SCIENTIFIC AMERICAN SUPPLEMENT. No. 1447

Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1903, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. LVI. No. 1447. NEW YORK, SEPTEMBER 26, 1903. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

FIG. 13.—PORTABLE BUCKET-CONVEYOR FOR LOADING COKE SACKS.

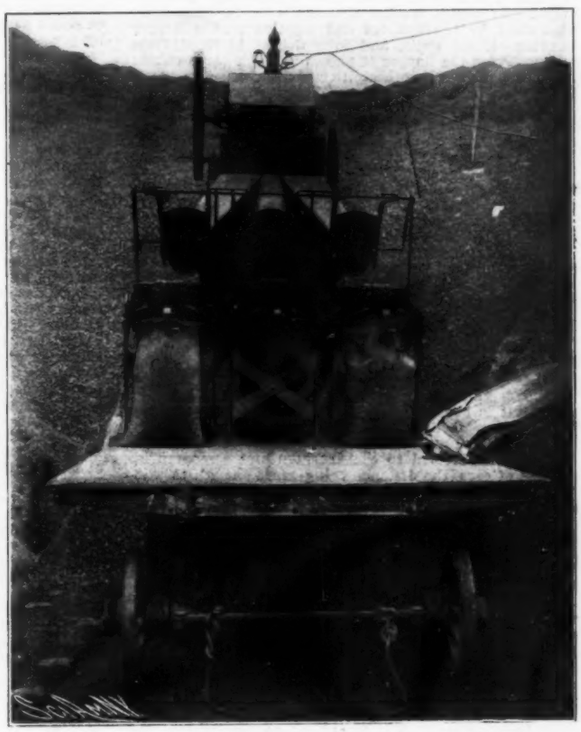


FIG. 14.—REAR VIEW OF BUCKET-CONVEYOR FOR FILLING SACKS.

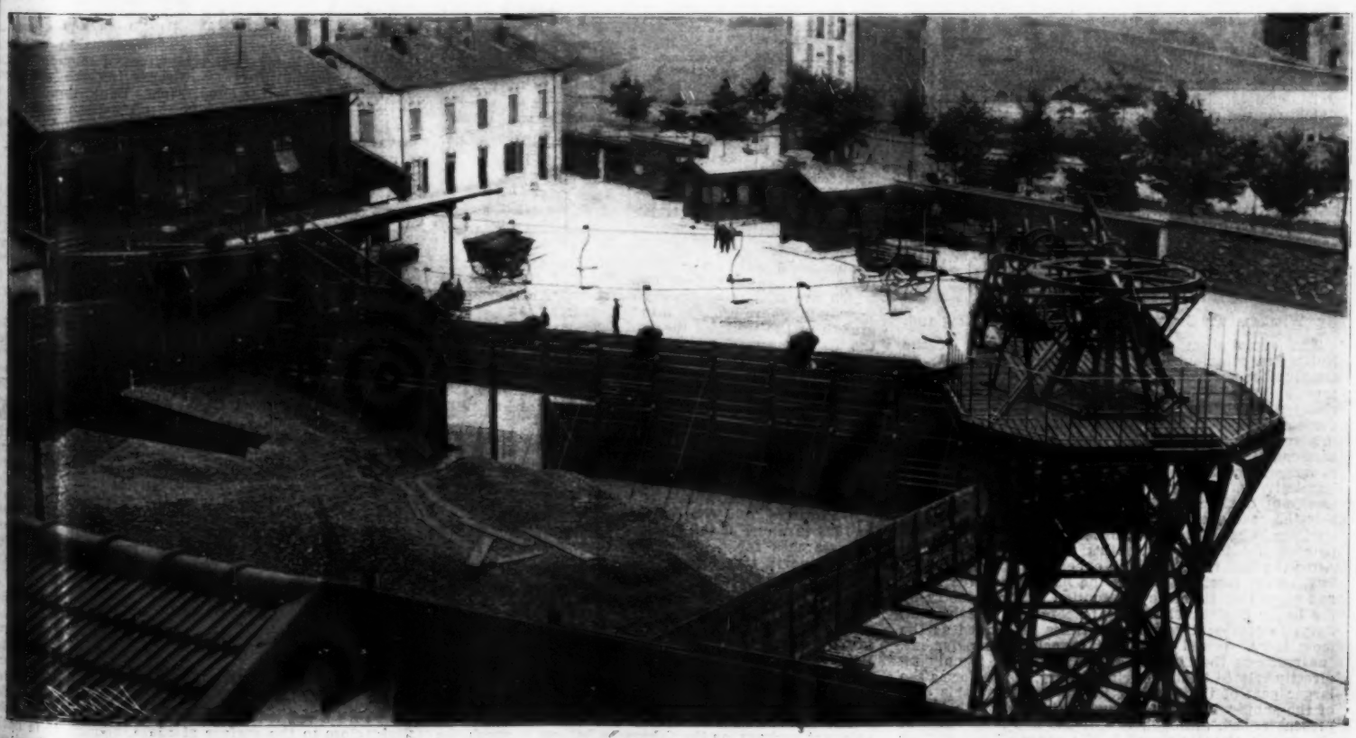


FIG. 15.—CONVEYING COKE BY AERIAL CABLEWAY.

THE MECHANICAL HANDLING AND CONVEYING OF COAL AND COKE.—III.

[Concluded from SUPPLEMENT No. 1446, page 23166.]

THE MECHANICAL CONVEYING OF COAL AND COKE.*—III.

Specially Prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by EMILE GUARINI.

As in certain cases the company has to furnish dry coke, advantage has been taken of the great distance that separates the crushers from the point at which the cars are loaded, to establish a drying conveyor. This apparatus consists of a conveyor of great delivering capacity provided with a continuous floor 6 feet in width, moving in a superheated inclosure with a speed of 1.6 inches a second. The wet coke coming from the crushers is continuously emptied upon the drying floor by means of a frame and buckets. After a travel of from 30 to 40 minutes in the superheated inclosure, it falls through a chute onto a bucket lift, which empties it into the cars.

The coke is taken up by buckets with hectoliter measures. The arrangement is such that there is always a tendency on the part of the buckets to bear against the heap of coke. The buckets are mounted upon two chains having detachable links. The coke is raised by the buckets and emptied into a hopper having sifting walls, and in which it is freed from dust. From the hopper it passes through three chutes into the discharging hectoliter measures.

The electric motor is placed beneath the platform at the extremity opposite the frame of the bucket and gives the apparatus stability. The power is 3,500 watts. The discharge of the apparatus varies from 1,050 to 1,575 cubic feet per hour, according to the size of the coke to be bagged.

In order to increase the effective capacity of the coke-runs, certain sides of the heap are surrounded by palisades of several feet in height, which constitute what are called "stationary shields." Upon opening a door in one of these, there is obtained a continuous flow of coke that can be received in the loading apparatus.

We have now finished the brief description of the apparatus employed by the Paris Gas Company at its works; but it must not be imagined that all these apparatus operate in all the works of the company. The selection of them has been determined by circumstances. Thus, for example, to the Clichy works the coal is brought by boat and unshipped by means of a crane actuated by a gas motor, while to the Landy works it is brought directly by rail, enters the works through an inclined plane, and is discharged either sideways or at the extremity. At La Villette, the coke is carried to the crushers and screeners by trains of cars, the distance being great enough to warrant it, while at Ivry, the distance being shorter, it is carried by dump carts. The same is the case at Clichy, although this works offers sensibly the same arrangement as that of La Villette. At this latter, the coke coming from the crushers and screeners is received in bags or skips for the loading of cars. The skips are raised above the cars by an automatic crane and discharged through the bottom. At Ivry, the bags are taken up by conveyors and put into wagons, or by telphers and piled. At Clichy, a horizontal conveyor and a carrier-lift (the first prolonged by an inclined conveyor) raise the bags to the level of the cars. This latter works is provided, in addition, with a continuous drying conveyor, such as has already been described. *Per contra*, the floor of the crusher shed is not here, as at La Villette, raised to the level of the platform of the cars in order to permit of the loading of the bags. The Ivry works has also the peculiarity that the dust is raised by a lift and emptied into oscillating skips which are rolled to, and discharged into, chutes for the filling of dump carts. At La Villette, some of the bags designed for the heap are carried by a horizontal conveyor, passing under the crushers, to the lift for putting in heaps, while others are carried by cars or dump carts to another elevation. At Clichy, the putting in heaps is done by means of conveyors, and is completed by means of monorails, the length of which, for the round trip, reaches 300 yards. At Ivry, a large portion of the carriage is done by telfers. In the three works that we have especially mentioned, the coke is removed from the heap by dredges, but at Ivry it is done likewise by the shields above mentioned. The works therefore present a certain variety, which is necessitated by circumstances, but in all cases the aim has been to obtain the most expeditious, most economical, and least fatiguing handling of the material possible.

* The method of handling coal and coke here described seems distinctly inferior to the American system; still, the method is not without merit and is worth while presenting to readers of the SUPPLEMENT.—ED.

THE NORTH SEA FISHERIES.

By WILLIAM P. SMYTHE, Consul at Hull, England.

THE exploitation of the teeming resources of the North Sea contributes so greatly to the prosperity of the Humber ports of Hull and Grimsby that a brief history of its development and a description of the changes which the industry has undergone, especially during the past twenty years, can not fail to be of interest. From the earliest times, the fisheries of the east coast of Great Britain have engaged the energies of large numbers of people, both men and women, and legislative efforts have from time to time been made to stimulate the industry. In Scotland, especially, was this the case a century ago. Bounties were given by Parliament with, however, unsatisfactory results, as is pointed out in Adam Smith's "Wealth of Nations." After the failure of repeated experiments of this kind, Parliament resolved to give the fisheries a free hand, and since that time the prosecution of the industry by the hardy Scotch fishermen prospered so greatly that, down to comparatively recent times, it ranked as the most lucrative and important branch of employment. Inasmuch as the Humber fishing industry is only indirectly related to the herring fishery, which forms the larger part of the Scottish fishing industry, this part of the subject has only been slightly dealt with in the present report, although liberal use has been made of the wealth of facts stored in the pages of painstaking Scottish authorities, notably Prof. M'Intosh, whose work, "The Resources of the Sea," is a standard authority upon the scientific aspect of the question.

ADVENT OF THE STEAM TRAWLER.

Up to the eighties, the methods of fishing differed little from those pursued in primitive times. The application of steam to the boats was an idea which had not been put into operation, probably because the fishermen are of all classes in the country the most conservative in their habits. In 1879, some steam tugs employed in the Tyne and Wear were thrown partially idle, owing to the prevailing depression in the shipping trade, and, in order to augment their earnings, the owners resolved to trawl in the inshore waters during periods of enforced leisure from employment of a more profitable kind. The result was that these improvised steam trawlers competed very successfully with the sailing vessels, so much so that the crews of the older vessels fiercely resented the newcomers. However, it was soon discovered that the tugs, being mostly of the paddle type, could not proceed far to sea; yet the remunerative nature of steam fishing had been demonstrated and capital was quickly forthcoming in order to build screw trawlers specially suited to the industry. At first, wood was the only material employed in construction, but the advantages of iron were early recognized, and later steel came into preference. The catching power of a modern steam trawler is estimated by practical men as equal to that of at least eight or ten of the old sailing trawlers, which, only twenty years ago, carried on fleeting operations in the North Sea. So striking an increase in the capacity of the boats could not fail to exercise an enormous influence upon the trade. In 1883, there sailed from the ports of Hull and Grimsby less than 20 steam fishing vessels and about 1,000 sailing trawlers, smacks, yawls, and luggers. Only four sailing vessels survive to preserve recollections of a past within the memory of the great majority of those interested in the trade. Lowestoft and Yarmouth made an effort to stem the tide of innovation by building sailing vessels of a more modern type; but these, too, have been disposed of and scattered among various continental ports where the old methods are still adhered to.

Official statistics bear out the effects of these revolutionary changes in the industry in a very striking fashion. In the first place, we see, as might be expected, that in consequence of the enormously increased efficiency of the vessels the total number of craft has declined. Taking England and Wales alone, the number of first-class boats—boats of 15 tons and upward—has fallen off from 3,509 in the year 1882 to 3,176 in 1900; but the number of men and boys constantly employed has only shrunk from 32,503 in 1890 to 31,589 in 1900. In Scotland, where the line-fishing industry at the small coast villages, so picturesquely described by Sir Walter Scott, has felt the pressure of the new competition acutely, the effects have been much more marked, the number of men and boys constantly employed having fallen off within the course of the last decade from 34,319 to 27,288, while the number occasionally employed has dropped from 20,829 to 10,288, or more than one-half. In this fact may be seen the explanation of the outbreaks of feeling which the trawlers sometimes excite in northern waters, and also the continual agitation, of which more will be said at a later stage of this report, in favor of the legislative restriction of trawling in inshore waters.

EFFECT OF STEAM TRAWLING ON THE GENERAL SUPPLY.

But while the enhanced efficiency of machinery has undoubtedly displaced many fishermen in the market, the effect has, broadly speaking, been for the general good. The English public in the great inland centers enjoys a constant and plentiful supply of all kinds of fish and the quantities landed are steadily increasing, as the following table, which is confined exclusively to the English ports engaged in the North Sea fisheries, clearly illustrates:

Ports.	1891.	1893.	1895.	1897.	1900.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Hull, Grimsby, and Boston	1,595,165	1,776,338	2,193,998	2,339,705	2,866,172
North Shields, Sunderland, Hartlepool, Scarborough, Yarmouth, Lowestoft, and Ramsgate	570,818	625,283	623,743	558,440	568,757

The fishes included in this table are cod, haddock, hake, ling, soles, turbot, plaice, and halibut, all of which are caught by trawls or lines. Another noteworthy fact here brought into strong relief is the rapid growth of the trade at the ports engaged in fishing in the distant waters, such as Iceland, the Faroe Islands, etc., as contrasted with the stagnation of ports like Scarborough, where no attempt has been made to embark upon the new enterprise, which, until the last year or so, has enabled capitalists to amass profits at an unprecedented rate.

ORIGIN OF THE HULL FISHING TRADE.

It is a curious fact that the enormous fishing trade of Hull, which dates from 1844, was originated by pure chance. Mr. W. A. Ansell, to whom I am indebted for the narrative, told the National Fisheries Conference in 1883 that one of the Ramsgate boats in prosecuting her searches for fish was, by adverse winds, blown farther north than usual, but, determined to make a try, they shot their trawl in what is now well known as the Silver Pits, and their venture was so well rewarded that they drew up their nets bulging with soles. Very soon this golden haul became noised abroad, and other boats followed and obtained similar results. Hull was found to be a convenient port of resort and gradually became the center of the North Sea fishery, until it in time had to yield pre-eminence to Grimsby, which possessed the advantage of being 20 miles nearer the sea.

The Silver Pits no longer yield teeming harvests of sole, not perhaps, as the fishermen believe, through the havoc wrought by trawlers, but through the migration of fish elsewhere, possibly to return to their old resort again. However that may be, it is certain that whereas it was not uncommon for a trawler to get there 40 to 60 pots (1 to 1½ tons) per night fetching $1.45 to $1.95 per pot, soles now fetch as high as from $12.16 to $29.20 per pot, the price having risen as the take diminished. Similar migrations are reported about the Heligoland fisheries and off the Texel.

USE OF ICE ON TRAWLERS.

The development of the trade recorded in the foregoing statistics may be traced to the use of ice, as is illustrated by the history of the Humber fishing industry at the ports of Hull and Grimsby:

PORT OF HULL.

Year.	Vessels.	Registered tons.	Value.	
	Number.			
1845	21	570	£6,425	$31,...
1878	330	19,800	247,500	1,204,...
1892	417	29,238	555,000	2,700,...

Grimsby in 1845 was not used as a fishing port, but thirteen years later—1858—a few of the Hull smack owners were induced to migrate thither, and others followed; but the fleets being too small in number to work the trade successfully, ice was introduced, by which means each smack could fish its own voyage, icing each haul until a sufficiency was obtained to make a payable trip, when he made sail for land. This introduced what is known as "single boating and icing in bulk." Hull also adopted the same system. In 1868 Grimsby had advanced to some importance, and the trade was in that year 26,621 tons of fish. In 1880 this had grown to 46,950 tons. Thus we may trace to the application of ice, and also, in the case of Grimsby, to special railway and dock accommodation, the great and rapid development of the North Sea trawling.

STEAM TRAWLER AND ITS APPARATUS.

A modern steam trawler, equipped with the most up-to-date appliances, costs from $20,000 to $30,000, and some of them are 100 to 130 feet between the perpendiculars and considerably more on deck, with a depth of 10 to 12 feet. Coal is usually carried in the side bunkers, which in the best ships have a floor of cement so as to minimize the danger from fire. The finest vessels carry about 60 tons of fuel in the side bunkers adjoining the engine room, and burn only about 2½ tons with surface-condensing boilers; but fairly good ships often exceed this quantity. The economy in fuel is shown by the fact that the earlier type of steam paddle trawlers used about 35 tons of coal weekly. Self-acting scuppers to carry off the water during heavy seas contribute appreciably to the seaworthiness of the newer craft; moreover, the lifeboats are placed in a position from which they can be launched with greater facility, while occupying less space than formerly. Another variation upon the old type is that the port number of the vessel is indicated by large raised letters and figures made of sheet iron riveted to the funnel, so as to be easily read through a glass at a distance; besides these, the vessel carries the same numbers on quarter and bow.

The ice house, which is one of the most important additions to the fishing vessels since 1883, is usually placed in front of the fish hold, and in the case of the larger craft receives 5 tons of broken ice before departing on a distant voyage. It is sent from the stores in barrels and passed from the cart to the hold by a funnel. So important has this feature become, that at all the ports factories have been erected for the manufacture of ice by the ammonia system, capable of producing from 50 to 200 tons daily. On the remote grounds where most of the work of the larger vessels occurs, the ice is placed over the fish after they have been gutted and consigned to the hold. The price of ice (at present $4.30 per ton crushed and delivered alongside the ship) is thus an item of moment in the trawling expenditure. On discharging the fish from Iceland, Faroe, or the Great Fisher Bank, the old ice is thrown overboard, and though it might seem economical to keep it for use in a subsequent voyage for the preservation of the offal—for which $2.45 per ton is got from the fish-manure companies—yet it is certainly the safer method. (M'Intosh's Resources of the Sea.)

THE OTTER TRAWL.

Another great change was effected about 1894 by the introduction of the "otter" trawl, the invention of Mr. Scott, the advantages of which over the old pole trawl were generally perceived and led to the extensive adoption of the idea. The feature of the invention is a pair of large wooden ends, shaped like a door, having in front two powerful iron bars, meeting to form a V and supported by two accessory stays, the whole forming a projecting apparatus to which the chain connected with the warp is fixed. Toward the rear, a perforated iron plate gives passage to two staves—one from each end of the powerful iron bars mentioned—for the attachment of the swivel for the trawl net. The lower portion of the wooden end is weighted anteriorly with a heavy bar of iron, which occupies nearly half the length of the apparatus. A special and powerful rectangular frame of wood, with a top switch block, is fixed at the port bow and taffrail for hoisting the ends on board, and they form a striking feature from a distance, as, with the boards, they project 6 or 7 feet above the bulwarks. The otter trawl is said to capture cod more freely than the beam trawl, as many as 20 score having been secured in one haul. Experience, indeed, has shown that its increased powers of capture are indisputable.

MODE OF FISHING.

On the Great Fisher Bank and elsewhere the trawl is usually down for five hours, although when working nearer home the time is regulated rather by the nature of the bottom than anything else. When productive ground is discovered a "don," or buoy, is placed in the sea, with a red or black flag by day and a white globe light close to the surface at night, though it is liable to be carried away by passing ships and the lamp broken. The buoy has a pole, with heavy iron bars at one end and toward the other end about ten flat pieces of cork, upward of a foot square. In one or two ships floats of skin, such as the liners use in herring fishing, with pole and flag, were substituted for the cork buoys,

or small pieces of cork on a string. The rate of speed when trawling is about 2½ knots an hour, but when proceeding on the passage to or from port, 11 knots is covered. The usual number of the crew is eight, and the method of remuneration varies at different ports. Usually, the captain and the mate have a share according to the amount captured, the rest being paid ordinary wages.

HOW THE LINE FISHERY IS CARRIED ON.

Taking into account the area of the North Sea and the number of people supplied with food from it, as well as the great variety of fish found therein, it may be regarded as the most important fishing ground in the world. Taking a line eastward from the Shetland Isles, and continuing southward to the North Foreland from shore to shore, whether in its shallows or in its depths, on its even ground or in its caverns, which the fishermen call pits or holes, fish of some kind or other are found in greater or less quantity. The variety consists of cod, ling, haddock, halibut, coalfish, whiting, and skate. These are the principal kinds caught on line, while almost every other kind which supplies the table of rich and poor is caught in the trawler or in the drift net.

So far as information can be gathered it appears that, as early as the beginning of the past century, the English and Scotch were already taking the greatest advantage of the fisheries of the North Sea. The Dutch were the only other people who prosecuted deep-sea fishing to any extent; but, although holding a prominent position in the line of fishery of the North Sea, and notwithstanding that their method of fishing is of the very best, yet in the number and tonnage of their vessels and in the number of men employed, they have been left far behind in the competition.

Previous to 1862, the long-line operations never extended beyond the Dogger Bank; but since then they have, year after year, been carried farther north and east, and now the whole area from Shetland southward is fished upon. As soon as the vessel arrives on the fishing ground the lines are got ready and the hooks baited. Where whelks are used as bait the shells are broken with a mallet and the snail is sorted out and carefully put on the hook. If lamprey or herring are used, they are cut into small slices and so put on the hook. A curious fact with regard to this kind of bait is that cod, haddock, or ling will seldom or ever accept the tailpiece of either lamprey or herring. The skate, however, is not so particular with regard to the joint. The lines are rolled into a wooden tray, usually 460 fathoms in each, and the hooks are placed with careful regularity in rows on the bottom of the tray. About two or three hours before sunrise the lines are laid out, the end of the line is attached to an anchor which is secured to a buoy, the vessel is steered away, and one of the men "pays out" or "shoots" the line while the rest attend to the anchor and buoys. When the whole length of the line is out it is allowed to remain two or three hours and then the hauling commences. As soon as a cod or ling is caught it is carefully pierced under the fin on the right side in order that the air with which the belly of the fish is inflated may escape. This operation—which is carried out very quickly—having been performed, the fish is dropped into the well or hold of the ship, through which water from the sea freely circulates. The cod and haddock are usually allowed to swim about freely; the ling and halibut are suspended by their tails, and, so confined, they are found to live longer. A day's catch may vary from 20 cod or even less to 300 or 400 cod and ling, and proportionate quantities of haddock and other fish. On the return of the vessel to port the live fish are put into chests or trunks which are kept afloat in the dock and adapted so that the water may circulate freely from without. The dead fish are landed in the market and sold at once. During the summer months the greater number of the vessels go to the cod fishing at Iceland and the Faroe Isles, where they fish with hand lines. The fish caught here are salted during the first part of the voyage, and the fish so salted usually find a market in Shetland, where they are dried and exported to Spain and Ireland for consumption by the Catholic population on fast days. The line-fishing vessels are generally insured in local mutual-insurance societies against total and partial loss up to a sum representing from one-half to two-thirds of their value, and the yearly cost of insurance seldom exceeds 2½ per cent of the amount insured.

POSITION OF THE LINE FISHERY.

In Scotland, the quantity of fish annually landed by trawlers—almost exclusively steam trawlers—has increased from 5 per cent of the total in 1890 to 20 per cent in 1900. In that country, the development of the trawling industry and the prolongation of the herring fishery have brought about a decline of the line fishery, especially in recent years, the actual yield of the line fisheries having steadily fallen off from 80,000 tons in 1890 to 38,000 tons in 1900.

In England and Wales it is difficult to say whether there has been a similarly marked falling off in the line fishery, for the reason that the official returns fail to classify the boats with the care which marks the statistical work of the Scottish fishery board. An estimate, however, which is considered good enough to warrant adoption by a contemporary writer on fisheries, puts the number of first-class sailing liners belonging to the east coast of England at 240 in 1889 and only 80 in 1898, while the number of steam liners has during the same period increased from about 40 in 1889 to 90 in 1898. Generally speaking, the sailing liners elsewhere are giving up the struggle, while the steam liners are coming in, although, it would appear, not to an equivalent extent. It is worthy of note, however, that the catch of halibut, which is exclusively taken by line, steadily increases, so that no theory of a large decline in the line fishery as a whole is tenable at the present moment. That it has suffered in particular areas is unquestionable, but there are indications that the worst effects of the trawler competition have been witnessed and that the industry will hold its own in future.

FISHING IN ICELANDIC WATERS.

Reference has already been made to the Icelandic fisheries, which the Hull and Grimsby boats, with their usual enterprise, have exploited within recent years in order to supply the English markets. That the boats should have practically annexed, in an industrial sense, these distant fishing grounds was due to the discovery that the coasts of Iceland teem with the commoner food fishes. The British fishermen are naturally regarded by the less enterprising Danes as intruders, and the gunboats which police the waters keep a sharp eye upon the foreign boats against infractions of the law forbidding fishing within the 3-mile limit. Many arrests are made, but as the hauls are generally very large, it is often remunerative to run the risk of detection, especially as, in the sheltered bays and inlets, it is possible to carry on operations with a good chance of evading detection. How rich the coast is in fish is shown by a recent article in the Field Naturalists' Quarterly, in which the writer, describing a trip in a trawler to these waters, remarks that "a trawler towing for six hours in the North Sea will catch less than its fellow on the Iceland grounds will often bring up in half an hour or less." The writer proceeds to give details as to the kind of fish captured in Icelandic waters during a recent voyage. He says:

"Off Portland haddock of a large and somewhat coarse size were principally taken. Cod and plaice were scarce; halibut were not numerous, but much more so than, later on, in Faxe Bay. The last named varied curiously in size, ranging from little fellows no bigger than a small plaice to monsters of 10 stone or more in weight. Arrived in Iceland, some curious differences were to be noticed. Haddock were still very plentiful, but of a smaller size than at Portland. The fish of Faxe, however, is famed for its finer and more delicate quality, the bay being reckoned, indeed, the best, although the farthest of the fishing grounds. The plaice, for example, like the haddock, seemed here of a more refined variety, approaching very nearly in freshness of appearance to the much-sought North Sea fish. Halibut was almost entirely absent, and such few as were brought up were all of diminutive size, contrasting strangely with the giants of Portland. Cod was still scarce, this state of things remarkably illustrating the gregarious instincts of the species; for on one occasion when the skipper had suspended work for a few hours to give the hands a much-needed rest, such a shoal invaded the waters as piled high the decks of every neighboring trawler that happened to be towing at the time, yet vanishing as suddenly as it appeared when our nets were once more shot. Suddenly, without warning, the waters were again filled with cod. Bag after bag, in towings of twenty minutes or less, was hauled in so full that the load had to be lightened alongside before it could safely be hoisted aboard. In a very short space of time the decks were choked fore and aft with the greenish fish. In less than two hours something like 4,000 fish must have been captured by the net."

ECONOMIC POSITION OF THE FISHERMEN.

When, in 1883, the late Prof. Leone Levi, the well-known political economist, presented a report to the Sea Fisheries Exhibition upon the economic position of the fishermen, he found that, as a class, they exhibited many signs of comfort; yet he came to the conclusion that the fisherman's lot was worse than that of the agricultural laborer. "While of the £11,000,000 ($53,131,500) produced by the fisheries scarcely 30 per cent, or £3,000,000 ($14 599,500), go to the pockets of the fishermen, of the £260,000,000 ($1,265,290,000), the total produce of the land, at least 25 per cent, or about £70,000,000 ($340,655,000), are spent in wages, giving in the case of the fishermen about £10 ($48.66) per head, exclusive of incomes from other occupations, and in the case of the agriculturist about £21 ($102) per head yearly, or, taking the earnings per family, less than $1.46 a week for the fisherman and about $3.89 a week for the agriculturist." But this opinion of the academic economist was promptly challenged by a higher authority upon the subject, viz., the late Mr. Spencer Walpole, who knew the fishing communities intimately. "No one," he said, "who had an acquaintance with fishermen would indorse Levi's statement. If you examine an ordinary fisherman's dress, you will find it warmer and more costly than that of the laborer; he consumes a larger proportion of animal food than the laborer; you will find rows of cottages not merely occupied but owned by fishermen, built or purchased out of the profits of the fisheries. Many of them own their own nets and lines, and some of them have a share in the boats in which they sail. Many of the masters are boat owners, with £250 to £1,500 ($1,216 to $7,300) of capital, who have begun their lives as ordinary fishermen." Prof. M'Intosh, of St. Andrews, adds, moreover, that in communities of sober and industrious fishermen, comfort is almost always present and want unknown.

Twenty years have elapsed since the introduction of steam revolutionized the fishing industry, yet, as Prof. M'Intosh points out, the condition of the sober and industrious liner of to-day is far from being destitute, and many are able to utilize the savings bank to acquire property or a competency for their old age. It could not well be otherwise when, with all the uncertainties of fishing, four men will occasionally have about $126.50 a week, or a single "shot" which produces $19.47 or $43.80 in white fishing. In herring fishing, again, a crew of two boys and a man may make $43.80 in a single night, and this in the year 1898. This holds good more particularly among the thrifty Scotch, but even in England a sober fisherman experiences little difficulty in providing against old age.

Of the various plans indicated by Leone Levi by which the fishermen might secure for themselves a larger proportion of the fruits of their hazardous occupation, many have been carried into effect during the years which have supervened. The application of steam power has, it is true, driven many of the smaller and inferior equipped vessels out of the race, but, on the other hand, the thrifty men, by putting their capital together, have built vessels of a more remunerative kind. For instance, a modern herring vessel must earn a gross sum of $7,300 before any profits can be distributed, yet in a fairly good season, such as that which has just closed (December, 1902), everyone interested in the voyage will receive not only a sum sufficient to maintain his family, but a considerable lump sum, which, if he be frugal, will form the nucleus of a capital fund large enough to start him eventually as part owner of a vessel.

A less satisfactory aspect of the matter comes into view when the movement of population from the fishing villages into the great centers of the industry, which has been brought about by the development of steam trawling, is taken into consideration. The break-up of old associations and the transference into the temptations of town life of a rude and simple class necessarily had unpleasant consequences. In the old days the ties of home were nowhere more in evidence than among the fishing community. Except during the absence of the breadwinners on the "fleeting" expeditions, the relations between a fisherman and his family were constant and unbroken. At the present time, however, new conditions govern the fishing industry. A large proportion of the men are absent from land the greater part of the year, fishing at Iceland or in other distant waters. Home life is almost impossible; hence, in great ports like Grimsby and Hull, the men become easy victims to the prevailing temptations of immorality and drink. In both towns the existing state of affairs is deplored by all thinking people, yet it would appear that, so long as men are put ashore at frequent intervals with plenty of money to spend and few responsibilities to check them, a radical cure is out of the question. Thrift is hardly in evidence among the younger men, yet their many admirable qualities are conceded by everyone. At a moment's notice they are ready to risk their lives to save those of others. Every year the annals of the sea are illuminated by instances of extraordinary personal heroism on the part of these men, and scarcely a month passes without a foreign government making recognition of the bravery of Hull and Grimsby fishermen toward imperiled fishermen sailing under an alien flag. Bluff in speech and simple in manner, these sturdy men fall all the more easily into the abounding snares of a great seaport; hence the depressing features to which reference has just been made.

(To be continued.)

TREATMENT OF PYRITES CONTAINING COMBINED GOLD.*

By the Belgian Correspondent of the SCIENTIFIC AMERICAN.

IT IS well known that in gold mines where the rock contains pyrites, the larger part of the gold is found in the state of combination and is invisible. This state is especially met with at depths and particularly in the case of the deep level, in the Transvaal, where the gold is found associated with metalloids. Such ores are termed refractory ores.

It is also known that the extraction of the gold contained in these ores presents great difficulties, that the chlorination method entails considerable losses of gold, that amalgamation does not yield anything, and that the cyanide process gives only insignificant results and is frequently impossible.

The liberation of gold from these ores by a rational process has ever occupied the minds of engineers, and a Belgian company under the direction and aided by the researches of Engineer Body has devoted ten years of assiduous labor to the solution of this problem, having at its disposal sufficient capital to persist in its aim.

The goal has finally been attained, and the company is now busying itself with the treatment of auriferous arsenical pyrites of Piedmont in the valley of Alza, Italy.

The company has acquired two concessions where the gold is found in the proportion of 20 to 25 grammes in rough rock unpicked. The mode of treatment pursued by the company is not based on the elimination of sulphur, but, on the contrary, upon its addition. This may seem paradoxical and contrary to all metallurgical principles; nevertheless, the results have been surprising, for according to the testimony of professors and savants, the yield of gold resulting, exceeds that obtained by means of leading and of cupellation employed as a check on the result.

Founded upon the poly-sulphurization, obtained by a chemical disaggregation of the ore in presence of special salts under the action of a temperature not exceeding a cherry red and of relatively short duration, the energetic action of this disaggregation disengages the gold from its most stable compounds.

In the Italian works at Pontegrande (Piedmont), this operation is effected in a muffle furnace heated by a special system by means of mineral oil, hardly more than 400 liters of oil being consumed for four muffles in 24 hours.

This furnace, entirely of brick, is constructed at the top of the steps of a plant in tiers. Its lost flames serve for the recovery of the salts admixed. Its disposition admits of transforming the arsenic set free in the operation, partly by way of distillation either in the state of orpiment or in the state of arsenious acid. Simple condensing chambers adjoining the furnace are provided for this purpose. On a lower story, a battery of three vats with agitators serves to dilute with water the products proceeding from the furnace and for the evacuation of the dissolved arsenic.

Under the influence of the chemical disaggregation followed by a lixiviation with water, the pyrites has undergone a transformation causing the dissolution of the arsenic, a black mud containing all the gold, a poor magnetic sediment. The products are susceptible to a classification according to density.

The mud is generally in the proportion of 10 to 15 per cent of the total mass of ore, and the sediment in the proportion of 65 per cent. The maximum percentage of gold contained in the mud depends upon the care bestowed upon the mechanical separation of this mud.

On a lower story is a large vat to complete the separation of the mud from the arsenical waters. Lower down are cell filters destined to receive the mud from the various apparatus.

The arsenical waters collected in a vast basin give off orpiment in the open air or under the influence of the acid vapors of the plant.

The gold in the mud is completely free and susceptible to cyanizing. This mud represents the quint-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

essence of the ore reduced to its ultimate limits of volume.

Concurrently with this single operation of disaggregation, the Belgian plant comprises a recovery of the salts admixed, so that it is not tributary to any other industry. It draws from the composition of the ore all its elements of action, save a small quantity of sea salt for the restitution of the salts lost through absorption in the residues.

The process is conducted with the aid of heating with mineral oil in a better manner than with any other fuel, which makes it practicable in any locality.

It yields, as a by-product, arsenic in the two states most favorable to its disposal, crude orpiment finding employment in agriculture against the vermin of plants and arsenious acid against the vermin of animals, without mentioning the other industrial uses.

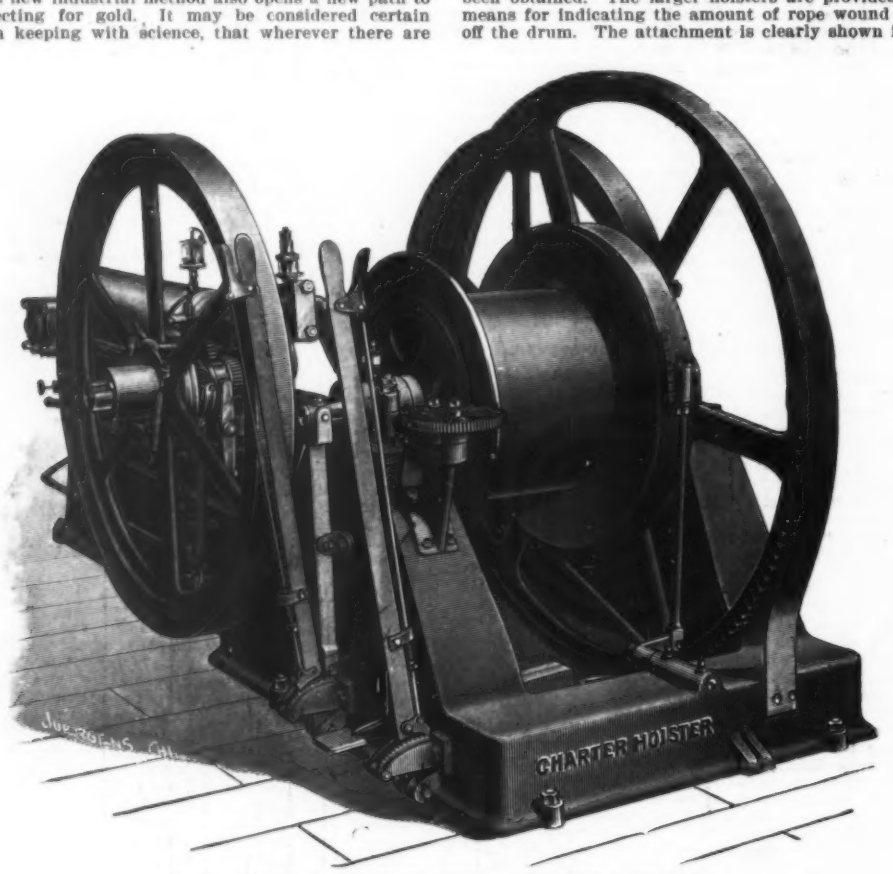
Hence, the process possesses all the advantages of recovery, the cost not exceeding 10 to 15 francs per ton of ore.

It will be seen that the process under discussion is not, properly speaking, a method of extracting the gold, but a process of transforming refractory pyrites into a product capable of being treated by the ordinary methods.

The products which take its place oxidize very easily in the air and assume at the end of a certain period an earthy aspect. They acquire all the characteristics of alluvia, the gold becomes perceptible therein, and the magnetic state is found.

In reality this process, as practised by the Belgians, is only the geological synthesis of the formation of alluvia, a remarkable and unprecedented result which merits the attention of savants, for it is the most striking confirmation of the theory which attributes the formation of placers to a volcanic action.

This new industrial method also opens a new path to prospecting for gold. It may be considered certain and in keeping with science, that wherever there are placers with free gold, there will also exist in proximity, in a volcanic matrix, a richer source of combined gold. This theory coincides with the suppositions of the English geologist Mors, and the Canadian engineers Ogilvie and Turell, with regard to the mines in the Klondike and the origin of the gold which is found there in such abundance.



MINE HOIST COMBINED WITH GASOLINE ENGINE.

MINE HOIST COMBINED WITH GASOLINE ENGINE.

No greater tribute to the successful development of the gasoline engine can be had than the fact that in spite of the popular prejudice which was at first entertained against all prime movers of this type, and for a time threatened to drive them out of the market, they are now considered indispensable in many fields, and their sphere of usefulness is being constantly broadened. In fact, manufacturers are constantly required to design engines for special uses and combine them with special machinery to meet the demands of the times.

One of the newest uses to which the gasoline engine has been adapted is the operation of mine hoists. Prospectors and miners have long known the locations of large veins of valuable ores, which they could not profitably work owing to their inaccessibility, or to the difficulty of establishing and maintaining the necessary power plant in their immediate vicinity. As accessories to the steam engine a steam power plant must comprise a boiler and a water supply to feed the same, also a large coal supply for the fire. The cost of establishing and maintaining such plant would in many localities foot up to a larger sum than the ore would bring. Miners are now waking up to the advantages offered by the gasoline motor for such work, and are beginning to appreciate its particular adaptability for operations of this character. A gasoline engine is very compact, of small weight per horse power, and complete in itself with the exception of a small tank for gasoline. Aside from these general characteristics, it embodies additional features which are familiar to all acquainted with the use of gas and gasoline engines. In consumption of fuel it is much more economical than the steam engine, for there is no waste of fuel while the engine is at rest, whereas with the steam engine the fires must be continuously kept up to maintain sufficient steam pressure in the boilers.

These and other considerations induced miners to ask the Charter Gas Engine Co., of Sterling, Ill., to build a gasoline engine, combined with a hoisting drum, in such a way as to make a machine that would be durable and easily handled. To meet these demands the Charter Company, which, by the way, is the pioneer gasoline engine company of the world, built the hoister which is illustrated herewith. This machine has met the highest expectations of the miners, and has proved to be perfectly reliable and durable and far more economical than a steam hoisting plant under the most favorable conditions. It is provided with a friction clutch, which may be easily operated and which is so arranged that there is no end pressure on the journals when the load is being hoisted. A special construction provides for taking up the wear of the clutch shoes. By means of a powerful brake with which the machine is equipped, the load can be held at any point and lowered at will. Another feature of considerable importance is the provision of a speeding device operated by the treadle shown in our illustration. This attachment permits the operator to vary the speed of the engine through a wide range, so that on picking up a load the machine may be run slowly to gradually overcome the inertia, and may then be accelerated until the maximum speed has been obtained. The larger hoisters are provided with means for indicating the amount of rope wound on or off the drum. The attachment is clearly shown in our illustration. On the side of the drum flange a spiral will be observed which meshes with a gear wheel. This, in turn, actuates a train of gears. The index fingers on top of the large gear have an adjustment by which they can be set to conform to the pointer, so as to give the exact position of rope for any depth within the capacity of the drum. The movement is absolutely correct, and being directly in front of the operator is quickly and easily read. The hoisters may also be furnished with drums of larger diameter than shown, if desired, so as to increase the hoisting speed and decrease the gross load lifted. With these principal features in mind the hoister will be readily appreciated by all those who are acquainted with the requirements of such work.

GERMAN ENGINEERING IMPRESSIONS OF THE UNITED STATES.

THE question as to the so-called American danger is attracting considerable attention in German iron and steel and machinery circles, where opinions are divided as to the possibility, or probability, of producers in the United States coming forward as serious competitors on a large scale in European markets in the near future. With a view to obtaining information on the subject, Herr H. Lueg, of Düsseldorf, and Herr Moritz Boeker, of Remscheid, recently paid a visit to the United States, the latter being accompanied, in his private capacity, by Baron von Rheinbaben, the Prussian Minister of Finance; and the impressions gained by the two former gentlemen have just been communicated to a joint meeting of the northwestern section of the Association of German Iron and Steel Producers, the Association of Ironworks Owners, and the Association for the Preservation of the Economic Interests of Rhineland and Westphalia. As the views of the German representatives will also be of interest in Great Britain, a summary of their impressions is given here.

The report of Herr Lueg refers, in the first place, to the intensity of labor and practical equipment of the works in the United States, and states that almost all the work at the Edgar Thomson Steel Works and the Homestead Steel Works at Pittsburg is done automatically, so that scarcely any men are seen from the running of the castings to the transfer of the steel to the rolling mills. The method of organization has been carried out in the best possible manner, and it is surprising that the management is largely vested in the hands of young men, of whom many are German engineers. If the equipment of the works is practical, Herr Lueg discovered no properties, in so far as the construction of large machines is concerned, which render them superior to German works, or, indeed, of any products of the machine industry. Less attention is paid to the question of working the machinery economically; much greater weight is laid upon quick delivery, simple construction, and convenient arrangement than upon durability and economy of the machine. The American industry possesses a great advantage owing to the cheap railway rates and the high degree of specialization in the machine industry, and with the immense area of the inland market and external markets it is an easy matter to manufacture for stock machines, which are disposed of in a comparatively short space of time. In addition to this the American consumer largely accommodates his wishes and demands to those of the producer, who is thus enabled to construct large and valuable machines in bulk. The report proceeds to observe that it would be presumptuous to suggest that the large working equipments of the United States could be equally introduced in Germany. The Germans live under totally different circumstances, and have to accommodate themselves to these conditions; but they could lay themselves out more advantageously than hitherto. For instance, it would be difficult to renounce entirely the German taste for beauty, but too much weight should not be laid upon external appearances. In this respect the customers, and especially the officials intrusted with the acceptance of machinery under German government contracts, could help the industry to a large extent instead of strongly condemning trivial blemishes in machines and parts of machines, and causing many difficulties and expense to producers owing to hypercritical examinations and tests. As the Germans do not possess the large market held by the Americans, they should first of all endeavor to induce purchasers to accommodate themselves to the requirements of suppliers, and not compel manufacturers always with each order to alter the type of construction and lead them in the direction of finding that scarcely two large machines are built which are absolutely identical. In this connection the report submits that scarcely an American firm exists who would submit to the rigorous conditions imposed in Germany in the case of large machinery. Herr Lueg goes on to suggest that as the export of German machinery to the United States is out of the question, owing to the operation of a tariff eight times greater than the Teutonic duties, the Germans must see that they are not squeezed out of other markets by the Americans, although the latter will become severe competitors on the decline of the inland demand. In conclusion, the author remarks that the good arrangement of the American works has impressed him, but he is not dazzled by their productions. The German firms can very well bear comparison with the Americans, and they need not take the so-called American danger too seriously, while, at the same time, not neglecting to introduce improvements suggested by experience. The conditions of production in Germany are in no way unfavorable; labor conditions are decidedly better, and the German machine tools are at least as good as those of their rivals. Thus, where there is no question of manufacture in bulk, the cost of production in America is near that of Germany, even if it does not exceed it. In the case of pig iron and semi-finished iron and steel goods, the American works, apart from the mineral riches of the soil, have material advantages in the matter of cheap freights owing to the co-operation of the railway and waterway companies, and Herr Lueg is of opinion that Germany can also learn much from the United States in this direction.

Herr Boeker, who deals at some length with the subject of trusts in the United States, points out that it cannot be accepted that the American works are much more advantageously situated than the German in regard to competition in pig iron, but that the question becomes more serious in the case of semi-finished and manufactured iron and steel. This is attributed to the decidedly lower cost of production, as compared with competitive countries, of rails, steel bars, constructional steel, sheets, wire, etc., which are turned out in bulk by automatic machinery attended by a minimum of workmen and with a cheap supply of coal available for use. The Steel Trust must and will endeavor to utilize the machinery to the fullest extent, and in case of a decline in trade it will seek orders in other countries at low prices. It may safely be expected that in times of economic depression America will try to dispose of its semi-finished and manufactured iron and steel in Germany, as in other countries, and Herr Boeker therefore suggests that Germany indispensably needs a sufficiently protective tariff to meet the circumstances of the case. The author concludes by observing that Germany should learn from America the basis of the latter's strength, namely, the specialization of industry and the cheapening of production by the introduction of labor-saving machinery as far as possible, and he suggests that the Teutonic syndicates should aim at the distribution of work among the members connected with these combinations in an improved manner to that which at present prevails, and particularly in regard to the export trade.—Engineer.

American Barbed Wire in Paraguay.—Among the American manufactures that come to this port barbed wire, by reason of its good and lasting qualities, is more acceptable than that which comes from Europe, although the latter is cheaper. The American wire gives more satisfaction than the wire of any other country.—John N. Ruffin, Consul, Asuncion, June 18, 1903.

STEAM TURBINES.*

By PROFESSOR RATEAU, Paris.

As is generally known, it is to the Hon. C. A. Parsons principally, and to the Swedish engineer De Laval, that we owing the general introduction of the steam turbine into practical engineering during the last ten years. It should, however, not be forgotten that the idea of this type of motor had already taken form in the brains of several inventors, and that, among them, the French engineer Tournaire is entitled to particular mention as having in 1853, just half a century ago, indicated the capabilities of the steam turbine. The disposition Tournaire indicated is almost exactly that developed thirty-two years later by Mr. Parsons, with, it is true, some very ingenious improvements which have assured the success of the engine. Tournaire also conceived the helicoidal gearing since adopted in the De Laval system.

As in the case of reciprocating steam engines, steam turbines are heat engines, converting the calorific energy of the steam into directly-available mechanical energy. From another point of view they are analogous to hydraulic turbines, and form part of the general class which the author will call "turbo-machines." To a person well grounded in the thermodynamic properties of steam, and possessed also of a thorough knowledge of the theory of the hydraulic turbine, nothing is easier than to design with confidence a steam turbine to satisfy a given purpose, provided, it should be understood, that he has previously determined the working coefficients to introduce into his calculations. Piston engines are not susceptible of such exact calculations, owing to losses at the admission and exhaust ports, and also to cylinder condensation. In turbines the expansion of the elastic fluid can be pushed to its extreme limit much more conveniently than in the case of piston engines, whence they share the advantage of employing condensers giving the best possible vacuum. On the other hand, friction and leakage increase in proportion as the pressure is raised. From these opposite conditions it results that, for low pressures, turbines are more advantageous than reciprocating engines, while they generally consume more than the latter when the pressure of the exhaust is that of the atmosphere, or higher.

As in the case of their hydraulic analogues, steam turbines may be divided into two principal classes—action and reaction turbines; and each of these classes is subdivided accordingly as the turbine is composed of a single wheel or of several wheels, traversed successively by the steam in course of expansion. Among reaction turbines (analogous in hydraulics to the well-known Jonval turbine), of which, as multiple machines, the prototype is the Parsons turbine, the steam is only partially expanded in the distribution, and acquires its full expansion in the movable wheel. The steam therefore acts on the blades at once by its pressure and its velocity. The movable wheel is thus subjected on its two faces to pressures of different amounts, causing longitudinal thrust, which has to be balanced. These differences of pressure render it necessary to reduce to a minimum the clearance between the movable wheel and the wall by which the steam tends to escape without traversing the blades and so doing useful work. It is indispensable that the distribution of the steam should be effected over the whole circumference of the movable wheel, in order to avoid movements of pulsation very prejudicial to efficiency.

In the "action" turbine, on the other hand, the steam only acts on the movable wheels by its velocity. Each wheel revolves in a casing in which the pressure is uniform. Therefore the steam does not produce any sensible longitudinal thrust on the moving parts, which dispenses with the necessity for any special provision to neutralize such thrust. The steam does not tend to rush across the blades in order to pass from one face to the other at the expense of efficiency. It is therefore possible to provide sensible clearance between the moving and fixed parts, and consequently to disregard the wear of the shaft bearing. Further, it is possible, if need be, to project the steam on to one point only of the circumference. Finally, under the same conditions, "action" turbines revolve at a less velocity than "reaction" turbines. This renders more easy the direct coupling to the machines worked.

The prototype of the simple-action turbine is that of De Laval. The author conceives that the multiple-action turbine offers greater advantages. It is therefore a motor of this type that he has developed latterly. His turbine, known as the "multicellular," is composed of sheet-iron wheels in greater or less number, fixed on the same shaft, and separated one from another by flat diaphragms. Many of these machines are already at work. Wheels of single sheet iron suffice up to a diameter of about 1 meter (39 inches); above this diameter it has been found advisable, in order to avoid deformation, to make the wheels of two conical disks of that metal. These multicellular "action" turbines can be disposed so as to run with very little loss from friction or from leakage, and, as a result, the consumption of steam is proportionately small at any load.

It is not necessary to insist on the well-known advantage possessed by turbines in general of their smooth and continuous movement of rotation; but the excessive speed for which they are obliged to be designed, in order to meet the speed of flow of the steam constitutes in many cases a serious inconvenience, e. g., in its application to ship propulsion. For a long time this hampered their use for electric installation, but latterly dynamos of very high speed have been constructed, worked by steam turbines, constituting an outfit of light weight, requiring small space, and, although of ample power, of low cost, and, as a consequence of working and upkeep, as simple as can be desired. It follows that for this purpose the steam turbine may be expected rapidly to supplant the piston engine.

Direct-coupled to ventilators and centrifugal pumps, steam turbines, owing to their capability of producing great power at high speed, exhibit surprising results. The author has installed turbo-ventilators giving a pressure of half an atmosphere, and turbo-pumps with a lift of several hundred meters. He is prepared to install plants of several thousand horse power compressing air to more than 6 atmospheres, or raising water to more than 600 meters (say 2,000 feet). This shows that the steam turbine possesses vast possibilities.

* Paper read at the Engineering Conference of the Institution of Civil Engineers, Section V.

AUTOMOBILE CULTIVATOR.

"WHEN a piece of land is properly dug, aerated, and worked," wrote the lamented Father Deherain, a few years ago, "the habitually inert nitrogen that it contains undergoes a change and becomes soluble and assimilable. The nitrated organic matter of the humus, attacked by ferments, is reduced to carbonic acid, water, and nitrates."

As the result of experiments carried on for nearly ten years, the eminent agriculturist reached the conclusion that it was extremely advantageous to reduce the soil to powder. Earth well mellowed and pulverized, in fact, is very porous and contains small cavities filled with air and water—conditions that are essentially favorable to the activity of the nitric ferments. Now, the small particles of earth consist of an aggregation of sand, clay, limestone, and humus.

The limestone, as long as it exists in proper proportions, and is held in solution by the carbonic acid of the humus, prevents the union of the clay of the contiguous particles; but, when copious rains supervene, the limestone disappears from the particles of earth, and the latter are converted into mud, ceasing to be porous, the earth contains less water and air, and nitrification no longer takes place. This explains the necessity of a continuous working of the ground with a view to effecting such pulverization after each harvest.

Unfortunately, the instruments and methods now employed scarcely permit of obtaining a perfect pulverization, and so it will prove of interest to make known the experiments that have been carried on for the past few years by M. Boghos Pacha Nubar, son of the celebrated Egyptian Minister Nubar Pacha, who has done so much for the industrial progress of the country. M. Boghos Pacha Nubar, who is a graduate of the Central School of Arts and Manufactures of Paris, is superintendent of the Egyptian railways. Incited by the principles laid down by M. Deherain, this engineer has devised a cultivator of an entirely new type, which, instead of cutting the soil into furrows, as plows do, mellows it very thoroughly and disintegrates the particles that compose it.

At the exposition of 1900 there was exhibited in the Egyptian section a very small model of a Nubar automobile cultivator which was tried near Fort Montrouge, in the plain of Bagneaux, before the eyes of the international jury, and gave quite interesting results. Other and more important trials have been made in Egypt on the property owned by the inventor in the vicinity of Cairo. The 1900 type of the cultivator was composed of two parts, viz., of a Fowler road locomotive and of the cultivator proper. This latter consisted of a frame supporting a steam motor supplied by the boiler of the locomotive, and, in the rear, of three disks provided with inclined colters revolving in planes at right angles with the forward direction of the machine. The frame was capable of being adjusted vertically upon the two wheels that supported it, so as to cause the colters to penetrate the earth to the desired depth.

The culture trials at Cairo were made upon coffee plantations with a view to comparing the influence of the pulverization of the soil with that of tilling by plow. In the first field, three tillages were made with as many plows, and the crop of cotton in the boll was found to be 2,750 pounds to the acre. In the second field, which was submitted to the action of the cultivator but once, the crop was 2,850 pounds. Through pulverization, there was thus obtained a surplus of 100 pounds to the acre with a much shorter time of preparation of the soil. M. Nubar thus ascertained that a half-day's work of his machine gave results sensibly greater than those obtained by sixteen days of ordinary plowing. But, in the course of his experiments, the inventor found that it was necessary to introduce certain modifications into his machine. The locomotive and cultivator formed two distinct masses wanting in cohesion, and the former, impeded by the weight of the latter, could not be guided readily, especially when turning corners. The weight of the complete machine exceeded 40 tons, which was too great. Finally, since the three colter disks were all of the same diameter, the machine left non-tilled zones. Such considerations led M. Nubar to devise a new automobile cultivator, which is now constructed in France at the Darblay establishment. In this, there is but a single vehicle provided with four wheels, the two hind ones of which are steering wheels with a divided axle, and the front ones driving wheels. A single steam motor produces, through friction gearing, simultaneously or alternately, as may be desired, the forward motion of the machine and the revolution of the colter disks.

The steam engine is of the Boulte and Larbodière type, with two compound cylinders in tandem. Steam, furnished by a small Niclausse boiler, is used at a pressure of 170 pounds to the square inch. The horse power developed is from 30 to 40. The total weight of the cultivator has been reduced from 18 to 13 tons.

Finally, the section tilled is improved through the substitution of three disks of unequal diameter (two of 10 feet separated by one of 6.5) for the three disks of the same size, the diameter of which was but 8.25 feet. The velocity of the large disks is 19 revolutions a minute, and that of the small one 29. Each of the first carries from 8 to 16 colters, and the third from 5 to 10. The fastenings of the colters to the disks are so arranged as to permit of varying the number according to the hardness of the ground and the degree of pulverization that it is desired to obtain. Finally, the projection of the colters beyond the disks is 16 inches, so as to permit of tilling to that depth. This new cultivator, which was operated in Egypt last year before a large number of spectators, was found to be

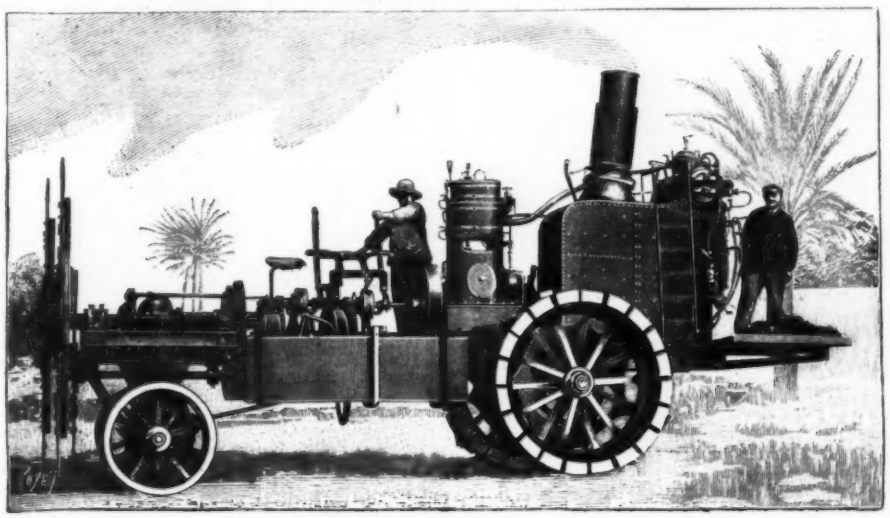


FIG. 1.—AUTOMOBILE CULTIVATOR.

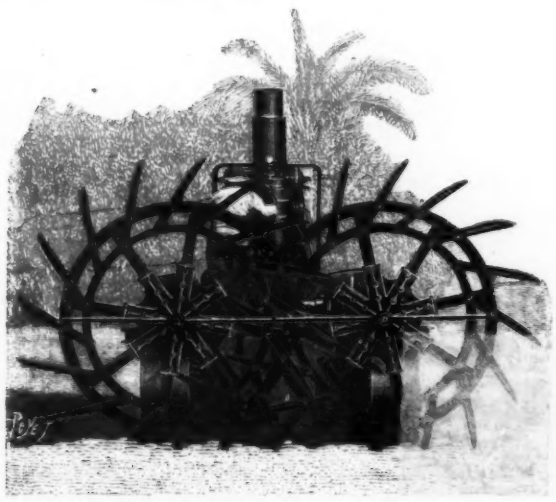


FIG. 2.—VIEW OF THE COLTER DISKS ON THE REAR OF THE MACHINE.

capable of advancing in ordinary soil at speeds of from 8 to 12 inches a second, while tilling to depths of from 10 to 12 inches. The effective width tilled was 9.5 feet. The surface tilled per hour, supposing a mean speed of 10 inches a second, would therefore theoretically exceed 27,950 square feet. But, taking into account stoppages and loss of time in turning around at the extremities of the field, which may be estimated at 25 per cent, the effective surface tilled per hour of work would be about 21,500 square feet, say over 4 acres per day of 10 hours.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

MANUFACTURE OF SPIRIT VARNISHES.

By CH. COFFIGNIER.

SCULPTURE VARNISH.—In a shellac varnish containing 200 grammes per liter dissolve, for the preparation of 10 liters of sculpture varnish, 3 kilogrammes of meltable Manila gum, 500 grammes of benzoin gum, adding 1 liter of alcohol. Various Manila varieties are rather difficultly soluble in alcohol, while others dissolve in the proportion of 90 to 100. The kinds which are, as it were, completely soluble in alcohol, are used for the production of spirit lacquers. The varnish prepared after the above directions is colored. A scarcely colored sculpture lacquer is prepared as follows: White shellac, 1 kilogramme; sandarac, 2 kilogrammes; mastic, 0.5 kilogramme; Venice turpentine, 1 kilogramme; alcohol, 10 liters. The varnish can be made in the cold and is readily filtered. French turpentine may be substituted for the Venice variety.

Black Varnishes.—Black spirit lacquers are employed in the wood and metal industries. Different kinds are produced according to their use. They are called "black Japanese varnishes" or "black brilliant varnishes."

Black Japanese Varnish.—Sculpture varnish, 5 liters; red acaroid varnish, 2 liters; aniline black, 250 grammes; Lyons blue, 15 grammes. If a sculpture varnish prepared with heated copal is employed, a black lacquer of especially good quality is obtained. Usually 1 per cent of oil of lavender is added.

Bookbinder's Varnish.—The following compositions are met with:

	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Shellac	14.5	6.5	13.5	6.3	8.3
Mastic	6.0	2.0	..	..	1.1
Sandarac	6.0	13.0	..	1.3	1.1
Camphor	1.0	..	0.5	1.5	..
Benzoin	..	..	..	..	13.7
Alcohol	72.5	78.5	86.0	79.2	75.8

Scent with oil of benzoin, of lavender, or of rosemary.

Other authors give the following receipts:

	Freundenwoll Per Cent	Wiegand Per Cent	Held Per Cent	Held Per Cent
Blond shellac	11.5	13.0	9.0	..
White shellac	11.5	..	..	..
Camphor	..	0.7	..	..
Powdered sugar	..	0.7	..	..
Sandarac	..	..	18.0	6.6
Mastic	..	..	..	13.0
Venice turpentine	..	..	2.0	6.6
Alcohol	77.0	85.6	71.0	73.8

All solutions may be prepared in the cold, but the fact that mastic does not dissolve entirely, must not be lost sight of.

Metal Varnishes.—The purpose of these varnishes is to protect the metals from oxidation and to render them glossy. They are mostly colored and may be used for decoration. Their chief employment is in the production of leaves, fruits, and artificial flowers, but they may also be used for porcelain, glass, bone, etc. I will give a few receipts:

	Per Cent	Per Cent	Per Cent	Per Cent
Seed lac	11.5	..	..	..
Amber	7.6	..	..	13.5
Gamboge	7.6	..	..	..
Dragon's blood	0.18	..	..	..
Saffron	0.16	..	..	..
Sandarac	..	11.2	15.9	16.6
Mastic	..	6.5	14.0	3.4
Elemi	..	3.3	..	..
Venice turpentine	..	..	1.0	3.4
Camphor	..	1.5	..	..
Aloe	..	..	7.0	..
Alcohol	72.96	77.5	66.1	63.2

As will be seen, only natural colors are used. The so-called "gold lacquer" is composed as follows: Sandarac 6.25 parts, mastic 3 parts, shellac 12.5 parts, Venice turpentine 2.5 parts, aloe 0.75 part, gamboge 3 parts, alcohol 72 parts. The solution is filtered. Applied in a thin coating this varnish shows a handsome golden shade. Other metal varnishes have the following composition:

	Per Cent	Per Cent	Per Cent
Shellac	17.5	..	18.0
Yellow acaroid gum	13.1	25.0	..
Manila	..	8.0	9.0
Alcohol	69.4	67.0	63.0

Scent with 1 per cent of lavender oil.

Gold Lacquer.—Yellow acaroid varnish 1 liter, orlean (annatto) 50 grammes, dragon's blood 10 grammes, golden yellow 5 grammes.

Red Gold Lacquer.—Red acaroid varnish 1 liter, dragon's blood 50 grammes, gamboge 20 grammes, orange yellow 5 grammes. To obtain dull shades, suspend an insoluble yellow dye in the solution and use shellac varnish.

Mal. Gold Lacquer.—Shellac varnish (20 per cent) 1 liter, annatto 10 grammes, Naples yellow 15 grammes. The last-named may be replaced with zinc yellow, which settles more slowly.

Copal Varnishes.—For these, such copals must be chosen as are easily soluble in alcohol. Heating of hard copals does not suffice to render them soluble in alcohol. A varnish due to M. Naudin, and composed as follows, deposits a sediment in the cold: Heated copal 17.8 parts, mastic 8.9 parts, sandarac 17.8 parts, Venice turpentine 8.9 parts, alcohol 46.6 parts.

Polishing Varnishes.—These always contain shellac and sandarac. An old recipe by Tingry reads: Seed lac 150 grammes, sandarac 60 grammes, elemi 45 grammes, alcohol 750 grammes. Common varnishes are those in which a part or the whole of the gum has been replaced with colophony, e. g.: Colophony 1.9 kilogrammes, red acaroid resin 900 grammes, gallipot 250 grammes, alcohol 10 liters. Dye with 1 to 2 per cent of artificial dyestuffs.

Varnishes Dissolved in Mixed Solvents.—By the admixture of ether a mastic varnish without residue is obtained, which dries very well. A purely ethereal solution would furnish a product drying too quickly. According to Held a white mastic and sandarac varnish is prepared as follows: Mastic 240 grammes, sandarac 240 grammes, ether 500 grammes, alcohol 1 kilogramme.

Picture Varnish (according to Winckler).—Mastic in drops 500 grammes, and chloroform, 1 kilogramme. Collodium varnishes are also largely used. The Compagnie Générale de Chromolithie has taken out a patent on the following composition: First prepare a mixture of nitrated cellulose 102 kilogrammes and camphor dissolved in alcohol 3.6 kilogrammes. This mixture is dissolved in acetic ether, 2 kilogrammes, sulphuric ether 250 grammes, castor oil 100 grammes, Venice turpentine 200 grammes, alcohol 7.5 liters, amylic acetate 10 grammes, and glacial acetic acid. To use this varnish cold there should still be added to every liter glacial acetic acid 400 grammes and amylic acetate 300 grammes.

According to Livache, photographer's varnish is a solution of celluloid in a mixture of amyl acetate and acetone. Acetone may also be used for dissolving.—Translated from Revue de Chimie Industrielle.

PYROTECHNY FOR PHARMACISTS.*

THE author defined the word which formed the title of his note as the production of pleasing scenic effects by means of combustion, and added that it had no relation to the manufacture of inflammables and explosives. The Chinese were the first who prepared and used fireworks; with characteristic closeness they kept the art a secret for some centuries. Not until about the thirteenth century were the properties of certain substances to impart color, luster, or crackling flame discovered in Europe.

At the present time pyrotechny had become a scientific art. The pyrotechnist required, first, a fair knowledge of chemistry, especially of inorganic and metallurgic, with a little of organic, and a rudimentary acquaintance with the principles of mechanics. The chief chemical process that came under observation was, of course, oxidation—a process that chemists were still unable to satisfactorily explain. Oxidation might be produced by the atmosphere, but in many cases this was not enough, and then the pyrotechnist had to employ his knowledge of chemistry in selecting oxidizing agents.

The chief of these oxidizing agents were chlorates and nitrates, the effect of which was to promote the continuance of combustion when it was once started. They were specially useful, owing to their solid non-hygroscopic nature. Then ingredients were needed to prevent the too speedy action of the oxidizing agents, to regulate the process of combustion, such as calomel, sand and sulphate of potash. Thirdly, there were the active ingredients that produced the desired effect, prominent among which were substances that in contact with flame imparted some special color to it. Brilliancy and brightness were imparted by steel, zinc, and copper filings. Other substances employed were lampblack with gunpowder, and, for theater purposes, lycopodium.

The author classified fireworks under four heads, viz.:

1. Single fireworks.
2. Terrestrial fireworks, which are placed upon the ground and the fire issues direct from the surface.
3. Atmospheric fireworks, which begin their display in the air.
4. Aquatic fireworks, in which oxidation is so intense that they produce a flame under water.

First and foremost among atmospheric fireworks were rockets, made in different sizes, each requiring a slightly different percentage composition. A good formula was:

Sulphur	1 part
Carbon, wood	2 parts
Niter	4 parts
Meal powder	1 part

Meal powder was a fine black or brown dust, which acted as a diluent.

Roman candles were somewhat after the same principle. An average formula was:

Sulphur	4 parts
Carbon	3 parts
Niter	8 parts

Pin Wheels—These were also similar in composition to the preceding. The formula for the basis was:

Sulphur	5 parts
Niter	9 parts
Meal powder	15 parts
Color as desired.	

Bengal lights had the disadvantage of being poisonous. A typical preparation could be made according to the formula given under:

Realgar	1 part
Black antimony	5 parts
Red lead	1 part
Sulphur	3 parts
Niter	14 parts

Colored Fires—Blue was prepared by combining together materials which yielded a green with a distinct blue and lavender, thus:

Chlorate of potash	8 parts
Calomel	4 parts
Copper sulphate	5 parts
Shellac	3 parts

Green had as coloring agent barium salts, thus:

Barium nitrate	16 parts
Chlorate of potash	16 parts
Sulphur	5 parts
Carbon	1 part

Yellow contains shellac, as a diluent meal powder, oxalate of soda (2 parts), and chlorate of potassium (4 parts).

Mauve:

Chlorate of potash	28 parts
Calomel	12 parts
Shellac	4 parts
Strontium nitrate	4 parts
Cupric sulphate	2 parts
Fat	1 part

Purple:

Copper sulphide	8 parts
Calomel	7 parts
Sulphur	2 parts
Chlorate of potash	16 parts

Slow fires were usually made in conical form; barium nitrate was added to give a green color, strontium nitrate for red, copper sulphate and calomel for purple, and sodium oxalate for yellow.

* Read by T. A. Elwood, F.C.S., A.I.C., before the London Chemists' Assistants' Association.

HERDS OF WILD HORSES STILL IN EXISTENCE.

THERE is a more or less general impression, encouraged to a considerable extent by magazine and newspaper articles, that the wild horse of the plains, so well known in the early days of the West, and about which so many stories of adventure have been written and so many romances woven, is practically extinct, says the San Francisco Chronicle.

Don't believe it.

I can take you to a range high up among the mountains of Nevada, within thirty miles of the station of Battle Mountain, on the much-traveled overland route of the Southern Pacific Company, and show you band after band of as genuinely wild horses as were ever "creased" or lassoed by the heroes of the early plains tales, existing under exactly the same conditions as then and just as difficult to capture. And what is true of this particular spot is undoubtedly true of other regions.

In the case of the wild horses of to-day in the particular section of Nevada concerning which this article is written, the history of the escaped war horses of the early Spaniards has to a considerable degree repeated itself. They owe their origin to a band of domestic horses which were turned loose on the hills and plains back of Sheep Creek Mountains, to the north of Battle Mountain, Nev., something over thirty years ago, by the late J. A. Blossom, a prominent land owner and mining man of that section. There they have since remained, breeding and running at will, and until the last two years or so no attempt has been made to capture them, except in rare individual instances.

For more than a quarter of a century they have worked out their own salvation, without let or hindrance, in a country as wild as when the continent was discovered, full of deep cañons and maze-like runways, and scarcely ever touched by civilization. The conditions are the same as found by their earlier prototypes, and like conditions have brought about like results.

The country over which these horses roam is ideal for their freedom, isolation, and concealment. The Sheep Creek Mountains are a comparatively short range, rising from the valley of the Humboldt River less than a half dozen miles north from Battle Mountain station, so abruptly that the 2,000 to 2,500 feet to their summit is made in traveling a distance of scarcely a mile and a half from their base.

In the region noted it is estimated that there are now in the vicinity of 2,000 wild horses, but their method of existence and travel is in small bands, numbering from a half dozen to twenty head. Each band has a stallion as its leader and there is practically never more than one stallion to a band. As soon as a male colt acquires growth and strength he is either driven out of the old band, or voluntarily leaves to form a band of his own.

The leader is in every sense and respect the master of the band. The members of his family are such by his will, and acquisitions are made only with his consent. The stock on the range is frequently added to by strays from distant ranches or from some vaquero camp. This has been particularly true in the past two years, when effort has been made to capture the wild bands, and a cowboy camp has been maintained in the hills for much of the time.

I have seen ironshod saddle mares, jacks, and even mules as members of the wild bands, all apparently as wild as the stallion leader, but I have never seen a gelding in such a band, and I am told that they are never permitted to join. The few that escape to the plains and hills may occasionally be seen in bands by themselves, and are certainly wild enough after a few months' running to be classed with any on the range, but they are outcasts so far as the majority are concerned.

When a single stray, either from another band, or from a ranch or camp, approaches a wild band, there is a careful inspection on the part of the leader before permission is given to join. Hidden among the sage brush I have watched a leader leave his band, stop an approaching mare and hold an apparent confab of ten or fifteen minutes before giving a decision. He touches noses with the would-be member of his family, walks all around her and examines her from every side as closely and carefully as an inspector of a cavalry corps, and finally either both join the waiting band or the outsider is forced to start off in a different direction.

The region where these wild horses exist both on

the "flat" and on the mountain sides, is gridironed with trails, made by the bands going for water. The horses never remain near the water courses after satisfying their thirst, preferring the open country.

Catching these wild horses is, as may well be imagined, exciting and difficult work. Among the men engaged in it, the work is called "running" wild horses, and that is what it amounts to. The vaqueros run them down by superior skill rather than by speed and endurance, and force them into some corral or some band of gentle horses, where they can be handled for market. Some two years ago R. C. Blossom, son of J. A. Blossom, and the present owner, started to round up this wild stock and turn them to some profit.

The work had been difficult in the extreme, owing to the character of the country, the resources of the horses themselves, and their great endurance. The principal thing necessary is to keep the horses on the run, giving them no chance to rest, and finally rounding them up in an exhausted state. The sight of a man on horseback is frequently enough to start a wild band going the entire day.

Working upon the knowledge of this fact, Mr. Blossom last year tried the device of mounting a lot of dummies upon captured horses and turning them loose, counting upon frightening and exhausting the wild horses that caught sight of them, and then running them down with fresh animals. The scheme was only partly successful, owing to the fact, Mr. Blossom believes, of his not being able to get enough dummies in the field.

The difficulties of the chase are enhanced by the fact that the quarry has learned to post sentinels on the lookout for danger. The country is nearly all rolling, and the first sight of a band is usually of one or two lookouts posted on the crest of a knoll, plainly on the alert, although miles away. On attempting to move nearer the entire band appears, and after a moment's gaze at the intruders start off on its "dirty trot," the stallion in the rear. This trot is as deceptive as the lazy lope of a coyote. It looks easy to overcome, but the pursuer soon finds that it eats up the miles with surprising rapidity, and that it can be kept up all day and all night if necessary.

When the band is met unexpectedly the most exciting work occurs. At close quarters the mustangs break into a run and the race is to the swift. Here, when there is no doubt that each member of the band will strain every nerve, the stallion takes the lead and makes every effort to pilot his family out of danger. But let the rider succeed in getting among the escaping horses, swing his riata and attempt to "lass" or "cut out" one of the mares, and the stallion will turn instantly and with mouth open, teeth gleaming and mane flying, rush at the disturber of his family unity with a fury that is both fearless and terrible.

There may be no real danger of attack or injury in such a case, but a rush of the sort that I saw a magnificent bay stallion make at Bob Blossom a few weeks ago, when Bob tried to cast his riata around the neck of the queen of the harem, looked like the real thing, and was sufficiently confusing to secure the band a fresh start.

A wild stallion is a jealous guardian of his host and will frequently turn threateningly even when the pursuer is a couple of hundred yards away.

The captured wild horse is far from being easy to handle, and his usefulness as a saddle horse is problematical. Under intelligent training at the hands of a skilled rider they may be made tractable, and their strength and endurance make them valuable animals, but one that has a strain of viciousness is a tough proposition and will warrant close watching.

A number of these horses were purchased some time ago for the German army. It is a safe wager that a few of Willie Hohenzollern's officers have ere this had a touch of the real thing in the bucking line that would rival an exhibit in a wild west show.

EYES THAT SEE IN THE DARK.

DR. AUSTIN FLINT has written the following article for Our Animal Friends:

Nearly every modern treatise on physiology begins with a description of the ameba. This animal is a single, simple cell, capable of various movements and changes of form, and of nourishing itself by the appropriation of surrounding matters. It is the simplest example of independent animal life, and is taken as the type of animal cells belonging to higher organisms. The development of mammals, and, indeed, of all animals, including man, begins in a single, simple cell almost exactly like the ameba, but with certain coverings which serve, not for its development, but for protection and for its attachments. This simple cell, united with a fecundating organism of microscopic size, undergoes multiplication by a process that is called indirect cell-division. The original cell is about one-hundredth of an inch in diameter.

In the process of development the daughter cells, resulting from the division of the original cell and the redivision and continued redivision of the daughter cells, build up finally the perfect creature. The cells which make up the new being gradually become specialized as to structure and function; some become hard by the appropriation of calcareous matter, and form bones; some become very contractile, and form muscles; some float in the blood and carry oxygen to all parts; some form the nervous system, which establishes relations with the external world and with other organisms, regulating as well the various internal functions; among those which establish what are called the functions of relation are cells so specialized as to give the sense of sight or vision.

In the animal scale it is not found that special nerves and organs are developed beyond the natural requirements of individual species. Specialization provides for division of function. A mollusc does not need and does not have a retinal eye. A dog or a cat needs no part for the exact appreciation of small details of objects and is not provided with an eye that would enable it to read, for example; but many inferior animals have requirements not necessary to man. Birds of prey can distinguish relatively small objects at immense distances when they would be invisible to the unaided eye of man; but human intelligence has produced the telescope, by means of which we can see further and better than birds. Nocturnal animals—certain insects, reptiles, fishes, birds, and mammals, including horses and cats—can see under conditions of comparative obscurity, or in what we call the dark, although it is difficult to conceive of vision in total absence of light; but man can provide artificial light. When organs of special sense in man are inferior to similar organs in lower animals, this defect is more than supplied by superior intelligence, as in the construction of aids to vision, and often man makes use of superior special senses in the lower animals, as, for example, the sense of smell in dogs.

In some of the very lowest orders of animals, as the hydras—which are little above the amebas—the faculty of appreciation of luminous rays is not localized, but it is probable that light produces some impression on the general surface, although this can hardly be called vision. The color-bearing vesicles (chromatophores) of chameleons are peculiarly sensitive to blue-violet rays and have nervous connections with the brain. It is possible that these vesicles, which are changeable in color, may be concerned in a sort of cutaneous vision; for, by reflex action through connections with nerve-centers, and possibly by voluntary action, the cells may be made to change their color. In certain pectens (scallops) there are little globular bodies, attached each by a cylindrical pedicle to the borders of the mantle, which are thought to serve as non-retinal eyes, and, indeed, are called by naturalists oculiform tubercles, or ocular peduncles. These are found in spondyles and in many other varieties of molluscs: but they are quite different from the cephalic eyes of the typical mollusca.

The most important difference between the human eye and the eyes of all other mammals except monkeys is in the presence in man of the fovea centralis, an ovoid, cup-shaped depression in the retina, lying exactly in the axis of direct vision. This little depression is hardly more than one-fiftieth of an inch in diameter (Schultze). In this part the anatomical elements of the retina which receive visual impressions are never stained by what is called visual purple or visual yellow. This is the only part of the retina that is used in near vision, as in reading. It exists in monkeys—animals that are supposed to be the immediate ancestors of man.

Impressions made upon the fovea, to be fully and exactly appreciated, require bright illumination of objects. The area of direct vision, indeed, is practically useless in obscurity. In near vision the pupil is contracted, shutting off a great part of the light from the general surface of the retina, the black layer of the retina absorbing the extraneous rays, and the crystalline lens changing its curvatures so that the image is exactly focused. In fact, the area of direct and distinct vision is used by day and the larger area of indirect, or peripheral vision, by night; but, of course, we use the area of peripheral vision also by day, for a general appreciation of form, distance, outline, and color. It is evident that the lower animals can have little or no use for a distinct and exclusive area of direct vision; still, if we watch monkeys and see them hold an object and examine it closely with almost human curiosity, it suggests a visual apparatus almost identical with the perfect human eye. The small extent of the area of direct vision is undoubtedly useful; for were it larger, it is probable that the mind would become confused by the extent and variety of impressions, and it would not be so easy to observe minute details and fix the attention upon small objects.

The area of indirect or peripheral vision is in the form of an irregular ovoid extending, for white light, about 90 degrees externally from the visual axis and about 70 degrees internally and vertically above and below. Cells of the outer layer of the retina, deeply colored, produce a liquid which stains the elements of the retina that are sensitive to light. This coloring matter forms in the dark and is gradually bleached by the action of light. Under ordinary exposure to daylight it becomes yellow. It is called visual purple or visual yellow. In the dark, after exposure to light, the intense purple color is restored, and the shades of color, between purple and yellow, regulate the sensibility of the eye to light. When we go suddenly from a dark room into a brilliant light, the eyes are dazzled, the light is even painful and vision is very imperfect; and when we pass from bright light into comparative obscurity, for some moments, until the purple is restored, vision is impossible. The change from purple to yellow is fairly rapid, and the eye readily accommodates itself to different degrees of illumination; but the change from yellow to white is difficult and slow and occurs only after exposure to a glaring light or to the direct rays of the sun. So far as is known, visual purple exists in all animals possessed of retinal eyes.

The term nyctalopia, applied to the lower animals and not to a disease of the human eye, means night vision. I had intended in this article to consider only vision in the domestic animals as compared with vision in man, but a short account of the development of the sense of sight in the animal scale has seemed necessary. Some domestic animals, especially horses and cats, see much better than man in the night and apparently quite as well by day. It must be that in these animals the retina is peculiarly sensible to light under conditions of feeble illumination, and it is almost certain that this is due largely to a greater production of visual purple. These animals also have elliptical pupils, which at night become immensely dilated. In the glare of daylight the pupil may be contracted to a narrow slit and the retina thus is thoroughly protected. Many nocturnal animals, such as owls and lemurs, have very imperfect vision by day, but in these animals the pupil is always round. The gecko, a small carnivorous, nocturnal lizard, has enormous eyes and a vertical elliptical pupil. Many fishes that inhabit great depths have protruding eyes of immense size. Insects, which have two enormous compound eyes with a large number of corneal facets, and sometimes, though not always, two or three small, simple eyes (ocelli), probably see well in the dark, although many see equally well in daylight. Bees see perfectly well by daylight, but they move about freely in their hives, which are quite dark, guided probably by the sense of sight.

A question, more or less speculative at this moment, occurs to me, whether it is not possible, and even probable, that nocturnal animals, and even horses and cats, appreciate rays that are not luminous and are invisible to us. In the ordinary spectrum are the luminous colored rays, which combined make white light. When returned to the eye from reflecting surfaces, some of the colored rays may be absorbed, and those which are reflected produce impressions of color. This occurs, also, when certain colors are absorbed by transparent media. In addition to the luminous rays, are invisible heat rays and invisible chemical rays. Those chemical rays which act on photographic surfaces are called actinic. Beyond the visible spectrum, especially at the violet end, are invisible actinic rays. We must take account, also, of the so-called cathode rays, emanating from the cathode, when a current from an induction coil is passed through a partial vacuum, and the X-rays, which can be obtained by decomposition of the cathode rays. We have, in addition, what are called Becquerel rays, emanating from substances like uranium, that absorb light and give off invisible rays in the dark, this continuing, it is supposed, for months and even for years. The recent discovery of radium makes us acquainted with invisible rays coming from this and other radio-active substances, which are given off for an indefinite time. All these rays will act on a photographic film; and many of them will pass through opaque substances, but are arrested by glass. It is known that the ordinary actinic rays are of very short wave length; and the wave lengths of the cathode rays, the X-rays, and rays from radio-active elements are assumed to be even shorter. The latter, including the cathode and X-rays—it is thought on account of their excessively short wave lengths—cannot be reflected or refracted and will pass through certain substances impervious to luminous rays. All these rays not only act on a photographic film, but have marked effects on living tissues.

All the rays mentioned, both visible and invisible, may be changed in their wave lengths by certain substances and are then given off in different colors. This is known as fluorescence, and it occurs only during exposure. All the invisible rays may be converted into visible rays by this same process of fluorescence, involving changes in wave lengths.

Certain substances give off fluorescent rays in the dark for a considerable time after exposure, and this phenomenon is known as phosphorescence. It is thought by some physicists that the peculiar light coming from the eyes of nocturnal animals in the dark is fluorescent or phosphorescent. It has been observed that the human skin will give off invisible rays acting on a photographic film; and, indeed, it is difficult to say what substances may not absorb and store up luminous or actinic rays and give off invisible rays possessing chemical activity.

This is not a severely scientific article; and I feel that I can permit myself to present here ideas which may seem visionary in a sense not intended to be conveyed by its title, acknowledging my reflections to be speculations, some of them without a positive scientific basis. With this explanation and provision, I trust I may be indulged in the following thoughts:

I do not know of any direct physiological observations on the comparative sensibility of the retina in nocturnal animals and in animals endowed with what may be called ordinary visual perception. Visual purple was extracted from the retina of the frog by Boll, in 1876. Kühne and others have since observed it in mammals and in man. It has been found possible to fix images of simple objects, such as strips of black paper pasted on a plate of ground glass, upon the retina by a process very like photography. When the invisible actinic rays were discovered, they were found to come directly from the sun or from certain bodies actually incandescent or luminous, although they exist, as well, beyond the visible spectrum. Now, we have, in addition, the cathode rays, the X-rays, and the rays from radio-active substances, all acting on a photographic film and all capable of exciting fluorescence and possibly phosphorescence. Most of these rays will not penetrate glass, but some will penetrate rock salt and transparent quartz.

I know of no comparative observations on the permeability to light of the transparent media of man and of nocturnal animals. It seems to me not impossible that the eye in nocturnal animals may admit rays that are invisible to us. The sensation of brightness is said to depend on the amplitude of luminous oscillations and color to depend on their frequency. It is generally admitted that invisible rays are of almost inconceivably short wave lengths; but they may be made to change their wave lengths, and thus become visible by fluorescence. It is thought that the perception of light and colors is due to the stimulation of structures in the retina, possibly producing vibrations corresponding in some way with the waves of light; that the waves of invisible rays are so short that they cannot be reflected, refracted or polarized; and certainly, as they are invisible to us, they are not perceived by means of the human retina.

It seems to me possible that certain rays may penetrate the eyes of some of the lower animals, which cannot enter the eye of man; and that such animals may possess anatomical elements in the retina sensitive to rays which give us no visual impression, these rays being radiated from many objects in obscurity. Observations have lately been made on the structure of the sensitive layer of the retina in nocturnal animals; and it appears from these researches —which are mainly anatomical—that the structures (rods) absorbing visual purple are unusually abundant and are of unusual length, and that the quantity of purple which they contain is unusually large (von Kries). It is generally admitted that visual purple adapts the eye to vision at low intensity. When we say that nocturnal animals see in the dark, we mean in obscurity, for it is by no means totally dark, even in the darkest night. Animals that live in total darkness, as in the depths of the Mammoth Cave of Kentucky, are blind—they have actually no organs of vision—while many so-called nocturnal animals present extraordinary development of the visual apparatus.

Possibly, rays invisible to us and not capable of

penetrating the human eye are emitted at night by a multitude of objects and pass into the eyes of nocturnal animals. Possibly, invisible rays, of excessive short wave lengths, are appreciated by peculiarly sensitive elements of the retina in these animals. Possibly, these are converted into longer waves by fluorescence, and the light given off by the eyes at night is fluorescent. Possibly, a change of invisible into visible rays—which is the essence of fluorescence excited by invisible rays—is an important element in perception by the dark-adapted eye. As regards invisible rays, if they cannot be reflected, refracted or polarized, and if they do not pass through an object, they must be absorbed; and they certainly have some sort of chemical action and must make some kind of an impression on sensible parts. Perhaps these are reasons why some animals can see in what we call the dark.

ALUMINOTHERMY.

ALUMINOTHERMY is a curious process due to Dr. Hans Goldschmidt, of Essen-Ruhr, and the principle of which is as follows: If, with a pulverulent metallic compound, an oxide or sulphide, for example, we intimately mix a metal in powder, the affinity of which for oxygen or sulphur is greater than that of the metal existing in the compound, and we heat such mixture, a reaction will occur at a certain temperature, with a disengagement of heat. The oxygenated or sulphureted body will be decomposed, and the metal that entered into the compound will be set at liberty, the oxygen or sulphur combining with the free metal. Unfortunately, in such a case, the reaction is so violent as to cause projections of the bodies present and a very rapid destruction of the apparatus in which the reaction occurs. Now, Dr. Goldschmidt conceived the idea of no longer heating the entire mixture, but of raising one point only of its mass to the proper temperature. The heat then extends progressively throughout the entire mass, and the reduction is effected without any exterior heat being required. It is easy to see the value of such a process, which may be utilized simply to afford a source of heat, or to furnish metal at the temperature of fusion to be employed directly and with the greatest facility in any sort of casting. In the process of aluminothermy, we cause the ignition of a mixture of a metallic oxide and pulverized aluminium, and the reaction, in developing a temperature of about 3,000 degrees, gives the metal of the oxide in a pure state, without carbon, and, on the other hand, a slag of oxide of aluminium, or artificial corundum. We shall see that such temperature and such reaction may be obtained almost instantaneously and without the use of any cumbersome apparatus. In fact, the oxide that is oftenest employed in aluminothermy is that of iron, that of the metal most used in modern metallurgy; and, under the name of "thermit," the Allgemeine Thermit Gesellschaft, of Essen-Ruhr, sells the mixture in question all ready to ignite and produce the reaction, as well as the fused iron, the composition of which is identical with that of a homogeneous soft iron. The tests show the breaking strength of this metal to be 38.7 kilogrammes per square millimeter (46,643 pounds per square inch), and its coefficient of elongation to be 19 per cent. Its normal composition, from a chemical point of view, is almost always the same. We find in it 0.10 per cent of C, 0.09 per cent of S, 0.04 per cent of Ph, 0.08 per cent of Mn, 0.03 of S, 0.09 per cent of Cu, and 0.07 per cent of Al.

When it is a question of utilizing the iron in fusion itself and not solely the high temperature of which it is the vehicle, it is possible to obtain a more compact casting through the addition of about ½ per cent of titanium-thermit. It is also possible to increase the proportion of silicium or manganese, all the additions to be made to the iron gradually at the moment of running it off. But let us see, in a general way, how this is done. The reaction can take place only in special crucibles made of iron plate lined with magnesia. If there were a silicate in the lining the aluminium in fusion would penetrate the wall. The ignition is effected by two slightly different processes, by means of a special powder, which is composed of a mixture of peroxide of barium and of aluminium. The iron, as a consequence of the reaction, becomes massed at the bottom of the crucible, while the aluminium, which is much lighter, floats on top. Moreover, from the viewpoint of weight, we find for each pound of thermit, half a pound of iron and about as much slag. The operation may be performed according to two methods, as we have above stated. When an "automatic" crucible is not employed, there are put into the receptacle a few ounces of thermit, or a few pounds, if the operation is performed on a large mass, and in the center is deposited a small quantity of the ignition powder which is lighted with a firebrand or with a bar of iron heated to redness. The workman who performs the operation should be provided with goggles furnished with smoked glass in order to protect his eyes against the glare of the incandescent mass. The charging of the crucible is finished by shoveling thermit into it. As soon as the last vestige of the thermit has burned, and consequently no more black particles remain upon the incandescent mass, the crucible is quickly tilted in order to decant the supernatant slag into an appropriate receptacle, and the operation is arrested as soon as the mirror-like and very characteristic surface of the liquid iron is seen. It is then possible to lift the crucible and run off the contents at the point where heat or fused metal is needed. But it is more convenient to have recourse to the automatic crucible, the bottom of which is provided with a tap-hole about half an inch in diameter, formed in a brick of magnesia, and closed by a disk of iron plate covered with two disks of asbestos with a little luting at the joints. An iron rod is afterward introduced into the tap-hole, and, when it is desired to assure the flow of the molten iron (which naturally occupies the bottom of the crucible), the rod is shoved in by means of a lever and thus lifts the iron disk.

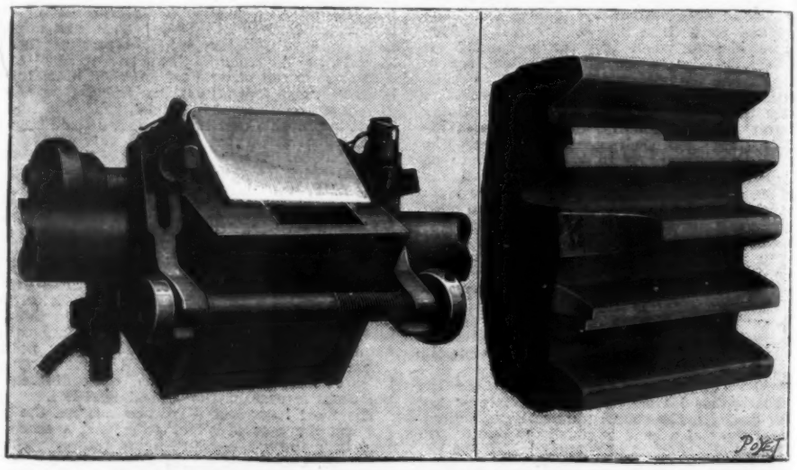


FIG. 2.—HORIZONTAL TUBE READY FOR THE FLOW OF METAL; AND SECTION OF A GEAR WHEEL WITH ONE TOOTH BROKEN, ONE REPAIRED BY ALUMINOTHERMY, AND ONE REPAIRED AND FINISHED.

FIG. 1.—ARRANGEMENT FOR THE WELDING WITH THERMIT OF AN IRON COUPLING AROUND TWO SQUARE BARS.

This method has more numerous applications. Nothing is easier, for example, than to weld iron to iron, to join two rails, beams, bars, or plates, of the most diverse profiles. Such a method of joining rails is less costly than that of fishing, and, as may be easily seen, the joint is more solid. The welding of metals by aluminothermy seems to us to have a vast field of applications. If the piece to be welded is small, it may, by plunging it into the molten iron, be quickly brought to the desired white heat of welding, and this will permit of afterward heating it by hammering or compression. It is possible in the same way to effect an excellent piece of brazing, the iron melting the solder and depositing the borax at the point desired. Autogenous welding also may be perfectly performed. The molten metal coming from the crucible is introduced into a mold at the place of the joint, and the ends of the pieces, as a consequence of the elevation of the temperature, become welded together perfectly. This process gives absolutely tight joints, and answers very well, too, for metallic pipes; but care must be taken not to allow the fused metal to flow too rapidly, since otherwise the pipes might be perforated. Care should be taken likewise to remove the metal that adheres to the pieces that are being welded before it becomes perfectly cold, since otherwise it would form a sort of ring or fish joint. Sometimes, with a view to reinforcement, it is well to leave this ring of thermit iron adherent. The operation is analogous to that described above, but the iron is allowed to cool in the mold, and if it is not desired that the ring shall completely surround the pieces to be joined, it will suffice to modify the arrangement of the mold. It is also possible to do welding by interposing thermit between the ends, spaced more or less widely apart, of the metallic pieces to be united. This is often done upon the tracks of street railways, with rails that it is desired to convert into a continuous rail. In most cases, at the moment at which the cooling begins, it is necessary to press the ends of the rails closely together in order to prevent any breakage of the joint under the influence of contraction.

FIG. 3.—WELDING RAILS WITH THE AID OF THERMIT. DIAGRAM SHOWING SECTION OF AN AUTOMATIC CRUCIBLE.

These processes are particularly valuable, since they permit of welding the largest pieces without their having to be displaced. Such pieces, moreover, are heated equally all around their profile, and the method is applicable to the most complicated surfaces. At the point of junction, we find an absolutely homogeneous metal presenting the best qualities of resistance.

With this method, it is possible to stop up a fissure or crack, or repair a defective casting, a broken gear tooth, etc., in all cases by flowing thermit iron in at the place where the metal is wanting. It is possible, likewise, to heat metals for the most varied purposes, and to raise to a red heat metallic pieces such as rivets that are to be put in place, by plunging them into the molten iron. The heating may be localized with the greatest precision by means of simple dams of molding sand. In order to pierce a hole in an iron plate, it suffices to direct upon the latter a jet of iron at a high temperature, when an aperture will be formed of surprising sharpness. If it is a question of adding a piece by way of repair, by using thermit for heating the surfaces of contact of the patch and the principal piece, the welding of the two will be assured. The molten iron may of itself form the patch, if a mold of proper form be employed. Finally, it is perfectly possible to have recourse to aluminothermy for the preparation of certain metals, such as manganese, chromium, and certain alloys that are beginning to be put to profit industrially.

If we add that the aluminium slag resulting from the reaction forms one of the hardest of abrasive materials, the reader will understand how great an in-

terest attaches to this new and curious metallurgic process.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE ELECTRICAL CONDUCTIVITY OF FIRE STREAMS.

IN modern cities there will often be a network of overhead wires running along the streets and over houses, and conveying electrical currents having various potentials. Many of these wires are uninsulated, and contact with them may produce disagreeable, if not dangerous, results, for even if the touched wire be on a low tension telephone or telegraph circuit, it may be crossed somewhere by a high-tension light or power conductor.

When fires break out, these wires often hamper the work of the firemen, for they not only offer a mechanical obstruction to the operation of the fire extinguishing apparatus, but the possibility of receiving an electric shock keeps the firemen from approaching them too closely. Of course the electric circuit can be broken at the central station or at some junction box, or the wires can be cut down, but this takes time, and if the wires be on a lighting circuit, may plunge a quarter of the town into darkness, which is particularly undesirable when there is a fire.

One of the supposed dangers to which firemen are exposed from live wires is that when a stream of water is directed on the wires, the current may pass through the water and then through the man who holds the hose. While the possibility of such an occurrence is admitted, there has been very little definite information on the subject, and therefore some experiments made by Herr Fried. Heinicke at the Charzow central station of the Upper Silesian Electrical Works, and published in a recent number of the Elektrotechnische Zeitschrift, are of interest.

Herr Heinicke directed a stream of water, under a pressure of 5 atmospheres, from a nozzle of about 12 millimeters (½ inch) diameter on to a bare live conductor, very well insulated from the earth, and which was struck by the whole section of the stream. The nozzle was also insulated from the ground, and the potential between the stream of water, at its issuance from the nozzle, and earth was measured by means of an accurate voltmeter. The distance between the nozzle and the conductor was varied, and the corresponding measurements of potential were made. Two kinds of water were used; one was rather hard and a poor conductor, and was taken direct from the regular supply, while to the other was added 0.5 per cent of pure soda.

The resistance of the hose which conveyed the water to the nozzle was found to be 5,000 ohms, and the resistance of the human body, from hand to wet earth, was assumed at 15,000 ohms. With these figures, and knowing the potential of the conductor and measuring the potential at the mouth of the nozzle, the respective currents flowing through the water, the hose, and the body of a man holding the nozzle were calculated. It was also assumed that a man could have a current of 0.03 ampere pass through him without injuring him.

The first set of experiments was made with a Y-connected polyphase circuit, having a voltage of 6,000 between two conductors, and with a grounded neutral. The three bare copper wires had each a section of 95 square millimeters (.15 square inch), and were well polished. Only one of them was struck by the stream of water. The first reading was taken with the nozzle 10 centimeters distant from the wire, and at this point the potential between the stream of water and the earth was found to be 130 volts, from which it was calculated that the current passing through a man holding the nozzle would have been 0.0637 ampere. The distance was increased and at 30 centimeters (1 foot) the current through the nozzle holder would have been only 0.0174 ampere, which could be stood with safety, though perhaps with some inconvenience. At one meter, the current would be only 0.00314 ampere, and at 125 centimeters (49 inches), no current at all would pass through the man at the nozzle. These figures were determined with the water from the regular supply mains, but when the water with 0.5 per cent soda was used, it was found that the length of the stream had to be increased to 1 meter before a dangerous current was avoided.

A second series of experiments was made on a polyphase system with a voltage of 125, in which one phase was directly grounded. With either kind of water it was not possible to get a dangerous current, even when the distance between nozzle and conductor was reduced to 3 centimeters (1.2 inches).

Experiments were then carried out with continuous current at 550 volts. It was only for distances of less than 8 centimeters (3.2 inches) and with the 0.5 per cent soda water, that a dangerous current was found. In the fourth set of experiments, with 240-volt continuous current, the distance between nozzle and wire was reduced to 5 centimeters (2 inches) without getting a current which would have endangered the man at the hose.

According to these experiments, the danger involved in playing a fire stream on live wires is not as great as has been supposed, but the quality of the water has considerable influence on the results, and experiments should be made in other places before it can be asserted that the man at the nozzle is safe from any electric currents which may by accidental causes flow through the stream.—The Engineering Magazine.

RADIUM EMANATION.—E. Rutherford and F. Soddy give a number of particulars of the "emanations" of thorium and radium which bring those two elements into closer parallelism and unify our views concerning emanation—i. e., the projection of particles or molecular aggregates which act for some time as independent centers of radio-activity. The main difference is that the intensity of the radiation from the thorium emanation falls to half its value in one minute, whereas that of radium takes four days to fall to half its value. This is in contrast with the fact that the excited or secondary radio-activity produced by radium decays in a few hours, while that produced by thorium requires days. "Thorium X" appears to be intermediate between thorium and its emanation, but no such intermediate "Radium X" can be traced. The emanating power of radium chloride in solution is about 200 times its emanating power in the dry solid state. Nevertheless, it is certain that the emanation is produced at the same rate in the solid, only it gets occluded, and rushes out on dissolving the substance. It is probable that the occlusion of the ultimate products of radio-activity is a common event in radio-active substances, and the authors suggest that probably helium is such an ultimate product.—Rutherford and Soddy, Phil. Mag., April, 1903.

ELECTRIC TRACTION BY THE SCHUCKERT SYSTEM OF SUPERFICIAL CONTACTS.

By EMILE GUARINI.

THE Schückert system of electric traction by superficial contacts, successfully experimented with at

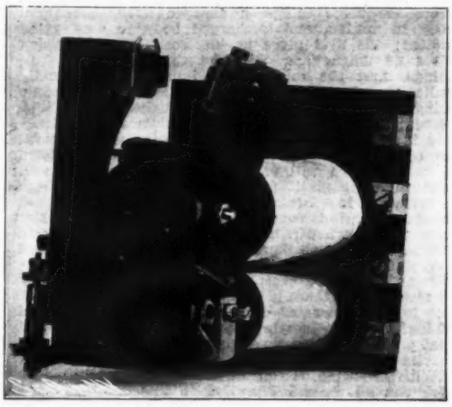


FIG. 1.—SPECIAL SWITCH-OPERATING RELAY.

Munich, presents the two characteristics of producing no sparks at the contacts and of affording absolute security from danger of shocks. These are two conditions that it would be found difficult to fulfill in other systems. In fact, all the systems of electric traction by superficial contact are based upon one principle in common: the contact, as soon as the collector has passed, must be automatically thrown out of circuit. All have also one defect in common, and that is that of producing sparks that get the apparatus out of order and are a source of danger to the public; whence the necessity of frequent inspection and considerable expense of maintenance. The sparks are particularly injurious in certain systems in which the electrical switch apparatus is placed directly under the contact. In such a case, the interior of the apparatus becomes quickly covered with carbonized matter that diminishes the insulation to such a point that shocks are given, even when the circuit is interrupted. In certain systems, fusible plugs have been adopted as safety arrangements, but without very good results. A grounded shoe placed at each extremity of the car short-circuits any contacts which remain excited after the passage of the car. This is very well in theory, but, in practice, unfortunately, it

FIG. 2.—CONTACT-BOX OPEN, SHOWING THE RELAY.

happens that the length of time taken by the shoe in passing over the contact is too short to allow the fusible plug to melt unless it has been proportioned to a current of very slight intensity. In such a case, it frequently happens that the intense current requisite for the starting of the car causes the plug to melt. On the other hand, if the fusible plugs placed in the apparatus should melt, it would be necessary, in order to replace them, to open the apparatus placed under the track.

In the Schückert apparatus, the current is taken up by means of a chain, and every contact is provided with a special relay (Fig. 1) inclosed in a box (Fig. 2). This relay acts as soon as the chain touches the contact plate and establishes the high tension power circuit. No sparks can therefore occur, since the contact is established before the current is switched on, and, on the other hand, it is not broken till after the current is cut off, which occurs before the chain leaves the contact plate. The latter, therefore, can-

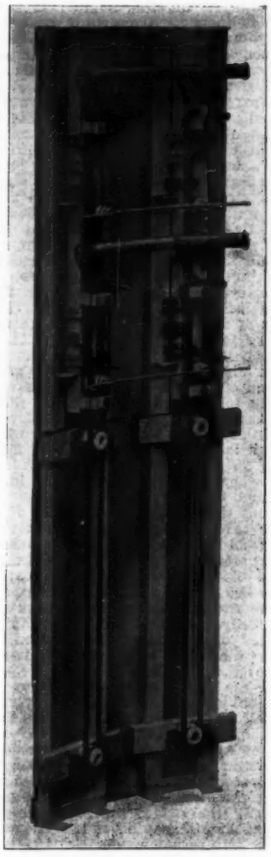


FIG. 3.—SECTION OF CONTACT BOX, SHOWING CONSTRUCTION.

not remain charged with high tension current. The power circuit in one section is broken the instant that of the following section is made. In other words, the contacting of the chain with one of the plates has a double effect: (1) It establishes a current in said contact plate; and (2) it interrupts the current in the one just passed, while it is still touching the chain. Owing to this arrangement, no sparks can occur, and no high tension current remains in the contact plates.

The relays do not necessarily have to be placed under each contact plate, but can be united in groups upon a board and placed at the most appropriate spot. The relays are ordinarily arranged in two rows of

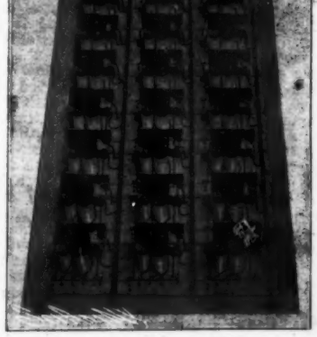


FIG. 4.—RELAYS MOUNTED ON PANELS.

19. Fig. 3 shows the method of connection in the interior of the distributing box.

The Schückert system possesses, in addition, the advantages over others of being capable of being installed more rapidly and at less expense. Besides this, the assurance of operation is greater, and the insulation is better. Finally, the possibility of running in either direction without commutating the apparatus, the possibility of adapting the system to cars of all kinds, the accessibility of the parts, and the reduced expense of maintenance are also advantages that militate in favor of this method.

ELECTRICITY AND MATTER.*

THE subject I have chosen is an enormous one, but it is one of exceptional interest at the present time. It is one of general interest as well as of scientific interest to students of physics. The fundamental properties of matter are now coming to be understood in a way in which they have never been understood before. What are these fundamental properties? One is cohesion, another is gravitation, and another is inertia. Concerning gravitation, we remain pretty much in the dark. It is an empirical fact that a body has weight, that two lumps of matter attract one another, with an extremely small force when we are dealing with ordinary pieces of matter, but extremely large when we are dealing with astronomical masses, such as planets or suns; but the cause of that gravitative attraction is not known, and at present appears to have little chance of becoming known. Cohesion ten years ago was in the same predicament, but cohesion now seems to be on the eve of yielding up its secret. The most striking fundamental property of matter, however, that we are beginning to understand in some degree, is that of inertia. Inertia is a popular term, but it is not always clearly understood what is meant by it. Let me explain the meaning. It may be defined as the power of overshooting the mark, or the power of moving against force. It is by inertia that a rifle bullet travels after it has left the gun. In the barrel it is urged by force; in the air the bullet goes on against an opposing force of friction because of its inertia—often in that case called the momentum. It is by reason of inertia that water runs uphill; we are sometimes told that water will not flow uphill, but that is a mistake. Heat will not flow uphill—heat will only flow from hot to cold; you cannot give it impetus and let it rush up of its own momentum, for heat has no momentum; it is not a substance, it only goes when it is pushed, and the instant you remove the force it stops. That is the case with heat, but that is not the case with any form of matter—it is not the case with anything possessing inertia. The water from a fountain rises because of the initial velocity imparted to it; for the same reason a cricket ball rises when it is thrown up; the propelling force has ceased, but the motion continues. It is the same with tides; for three hours the water is running uphill, for three hours it is running downhill. The head of the inflowing water is for three hours higher than the water behind it—the first three hours of the flow impart to the water its momentum, and the last three hours destroy that momentum gradually. The swinging pendulum is another illustration. (Having illustrated this point by a liquid horseshoe tube, showing the return to the position of equilibrium after a series of oscillations, the lecturer continued.) Oscillations like that are known to occur in electricity when a Leyden jar is discharged; the electricity does not go simply from the more highly charged to the less highly charged and there stop, but it goes beyond, it overshoots the mark and charges up that which was negative to positive, and then backward and forward, very like the oscillations in the tube. Hence it would appear as if electricity had a property resembling inertia. When I lectured here a quarter of a century ago I should have said that electricity has a property *resembling* inertia—I should have called it a mechanical analogue—an apparent inertia, simulating by inductive electromotive force the real inertia of matter. I should now go further than that, and should say that electricity has real inertia, just as real as matter; I should even go still further, and should say that in all probability there is no inertia but electric inertia; that the inertia of matter itself is to be explained electrically. In other words, what we are now arriving at gradually is *an electric theory of matter*. We are endeavoring to explain the properties of matter in terms and by means of what we know concerning electricity.

Although it may sound paradoxical to people who have not studied physics, we know more about electricity than we do about matter. Its properties have been more clearly investigated and more clearly understood than the inertia of matter, which is not understood at all. We only know its behavior. If a body is subject to a positive force it gradually increases its speed; if it is subject to an obstructive force it does not move in the direction of that force necessarily at once, but its motion begins to decrease, gradually stopping, and ultimately reverses its direction, if the force is continuous and if it is an active force. Many obstructive forces are only able to oppose motion like friction. In the text-books a bad example of a body obeying the first law of motion is given in the throwing of a stone upon ice, or some smooth surface. That is a bad example, because a single obstructive force acts all the time. The best example to give of the first law of motion is a case where there is a pair of balanced forces, where a propelling force acts all the time, just sufficient to overcome friction; e. g., a barge pulled by a horse, or a train drawn by a locomotive. When such a thing starts, the force is greater than the resistance, and the speed accelerates; when it stops, the resistance is greater than the propelling force; but when it is going on at a steady speed, i. e., for the major part of its journey, the force and the resistance precisely balance. The resultant force acting upon it is nothing. It is obeying the first law of motion. The barge moves, or the ship moves, or the train moves, simply and solely because of its own inertia. All the energy of an engine goes to generate heat and to overcome resistance. There is no propulsion in that; when it is going at a steady pace the positive and negative forces balance; the body is subject to zero force and obeys the first law of motion.

Now this property, a property analogous to inertia, belongs also to electricity; it was called self-induction, and its law has been made out for a long time, a law known as Lenz's law, which says that any change in a current is such as to oppose the motion. If you have a current of certain strength any cause which increases that strength calls out an antagonistic force. The force called out is always antagonistic to any change in the current. When a current is weakened, self-induction tends to make it persist in retaining its old strength. It is a property precisely analogous to inertia, and I now wish to suggest or maintain that it is a property which actually is inertia. It depends on a property which was first brought out mathematically by considering the case of acceleration of a charged body.

In a sphere charged with electricity, as long as it is at rest, we have the phenomena of electrostatics; directly it is in motion we get the phenomena of current electricity. A charged sphere in motion is a current, and we have to realize that there is no other current but that; a current is surrounded by magnetic lines of force; and when a sphere or other body charged with electricity is put into movement, a set of concentric circles of magnetic force surrounds its path, giving rise to a magnetic field. That magnetic field may seem extremely weak, but it is the measure of the current; and whether weak or not, it is now believed to be the only kind of magnetic field which exists. We are coming to realize that there are three things—a charged body, a charged body in motion, and a charged body in accelerated motion; the first gives us electrostatics, the second gives us magnetism, and the third gives us two things, first the evidence of inertia, and secondly radiation. Inertia and radiation are not the same thing, but both are manifest throughout the accelerated period. Inertia no doubt exists all the time; and instead of radiation I will use the more general term of "light"—light being the best known form of radiation. I will put inertia in a class by itself, because, although it is only manifested when there is radiation, it exists all the time. It does not depend on the speed, it is constant, and may be taken to exist equally well when a body is at rest. I want you to realize that just as there is no other electric field but that due to a charged body, so there is no other current or magnetism except that due to a charged body in motion, and there is no other radiation except that due to an accelerated charge; further, that one kind of inertia is the inertia of the charge on a body, and that *probably*, but not yet certainly, there is no other inertia except electric inertia.

With the time at our disposal it is impossible to give you all the steps leading to this conclusion. I can only give you a summary of the results. The idea of electric inertia as a reality and as due to a moving charge took shape and form in a magnificent paper by Prof. J. J. Thomson, of Cambridge, which appeared in the Philosophical Magazine in 1881, one of the most striking productions in the recent history of mathematical physics. It was a paper on the properties of a moving charged sphere, and it showed that a charged body possesses inertia because it is charged. It is important to remember that a body when it possesses a charge has, in addition to its ordinary mass, a supplementary mass, as it were, proportionate to the square of the charge, and inversely as the radius of the sphere on which it exists; or, as we may also put it, it is proportional to the quantity and to the potential. No great importance was attached to the statement at the time because of the difficulty of detecting any increase of inertia due to the electric charge in the case of a sphere of appreciable size. The extra inertia would be excessively small and impossible to detect if the sphere is of any perceptible size. Even if the sphere is reduced in size until it is a mere atom, and charged as highly as the atom can be charged, still the inertia due to the charge would only be an insignificant amount of the whole—not more than one hundred-thousandth part of the whole. That is to say, if you had one atom of matter charged with the maximum quantity which it can possess, and which you know in electrolysis or in chemistry, and if the inertia of the atom itself was one hundred thousand units, then when the charge was added it would be one hundred thousand and one; no important difference and not experimentally to be detected.

It depends, however, entirely how small the body is; the smaller the radius the bigger the inertia, due to the charge, will be. For a long time nobody thought of anything smaller than the atom; that was thought to be the limit, hence electric inertia seemed to be no more than a matter of mathematical curiosity. But about the year 1870 Sir William Crookes called attention to the phenomena that went on in vacuum tubes, and considered that the cathode rays were matter in a "fourth state," neither solid, liquid, nor gaseous. Sir William Crookes was not believed, and was rather jeered at for speaking of matter in a fourth state. However, the subject was investigated by a great number of different people in this country and in Germany; and the result of these researches, in which Prof. Schuster and many others, and notably Prof. J. J. Thomson, engaged, has been to show that Sir William Crookes was perfectly right; that the matter in the vacuum tube flying in these cathode rays is not solid, nor liquid, nor gaseous, does not consist of atoms, as had been thought, propelled by the cathodes and flying through the tube and causing phosphorescence where they strike, or X-rays, as the case may be, but that they consist of something much smaller than the atom, fragments of matter, ultra-atomic corpuscles, minute things, very much smaller, very much lighter than atoms—things which appear to be the foundation stones of which atoms are composed. Thomson measured the mass of these particles and found that they were of less mass than the atom of hydrogen; whereas the atom of hydrogen had been the lightest body hitherto known. These small corpuscles were about the one-thousandth of an atom of hydrogen in mass, and he further made this important observation, that whether hydrogen or oxygen or carbonic acid or any other gas was in the tube, the particles into which these substances seemed to be broken up by electric action were identical and independent of the nature of the gas in the tube. That is to say, the things shot out by the cathode did not depend upon what gas was in the tube; they seemed to be fragments of the atoms of the gas, but they were the same fragments in each case. This at once suggested the hypothesis, not yet by any means completely verified, that all atoms of matter may be composed of these same corpuscles, or electrons, as Dr. Johnstone Stoney had called them. Dr. Stoney had a habit of being in the van and of naming things before they had been discovered; thus they were called electrons long before they were known to exist separately—only the name belonged to the charge of an ion in electrolysis—a charge associated with matter; but in a vacuum tube these same charges are detached from the atom and fly free, a thing previously unheard of. In liquid conduction the charge and the atom travel together, they are inseparably associated; at an electrode or solid conductor the electron or charge is handed on to the metal and goes along the wires by some other means, but while they are traveling they are definitely united or attached to atoms all the time, although passed from hand to hand; in a gas it is not so, for it is just as if charges had been knocked off, charges of electricity dissociated from the matter, disembodied charges or electric ghosts flying through the tube at a tremendous speed. It was not only possible to measure the mass of the particles, it was also possible to measure their speed, and their speed was found to be something comparable to that of light, about one-thirtieth or sometimes even one-tenth of the velocity of light. Anything moving with that prodigious speed of several thousand miles per second must have a great amount of energy, and when stopped by a target naturally considerable results are produced.

Now for radiation of any kind there must be acceleration. The greater the acceleration the stronger the radiation. If you want violent radiation take a quickly moving charged body, and stop it dead; which is just what you do in the production of X rays, and what is done to some extent by minerals exposed to the cathode rays. These corpuscles have extremely small mass, and so their inertia is extremely small, but a body, no matter how small, moving with the speed of light, must have terrible energy; thus, by way of illustration, the energy of a gramme of matter (15 grains) traveling at the speed of light would be sufficient to lift the British Navy to the top of Ben Nevis. After the speed of these corpuscles that of bullets is rest in comparison. (Having shown by experiment a vacuum tube containing electrons in motion, the lecturer proceeded.) To show that these are charged particles in motion, it is only necessary to show that they have the properties of a current, that is, that they are amenable to magnetism—such as that of an ordinary steel magnet—and what you see going on in the tube is the nearest approach you have to seeing electricity. In that tube electricity is as isolated and as separated as we can ever hope to have it.

All electrical phenomena seem to depend upon these electrons. In the case of gaseous conduction what we observe is the flying of the particles—the bullet method or electric particles in free flight. When we deal with liquid conduction it is the slow traveling charges moving, but retarded or loaded with the atom of matter, having to convey the atom of matter with it; hence they travel very slowly, the atoms jostle and have to work their way through the rest of the material, and instead of going something like 1,000 miles a second they go more like an inch an hour; it depends upon what gradient of potential is applied. That I call the bird-seed method, meaning that the charge is carried as a bird carries a seed, the bird and seed traveling together until they arrive at an electrode, when the electron is dropped. In the case of solid conductors or metals the atoms cannot move along as they do in the liquid, they can only vibrate a little, are fixed, rigid, crystallized into their places. So when the electrons travel it must be because they are handed on from one to the next; each receives one and passes it on, not necessarily the same one; and this may be called the fire-bucket method.

A word more about radiation. If conduction is explicable in this way, how is radiation to be explained? Until quite recently radiation has been a puzzle. Atoms of matter vibrate; radiation is waves in the ether. Hence it used to be thought, and it did not seem puzzling at that time, that vibrating atoms of matter could generate waves in the ether just as a bell can generate waves in the air. The method by which light is generated was not clearly understood, but it was thought to be something analogous to the production of sound by a tuning fork or bell. But certain experiments made by me at Liverpool showed that matter and ether are disconnected from one another—that matter alone cannot generate these waves. It becomes necessary to assume that it is not matter which is vibrating so much as the charge on the matter—that radiation is caused not by the atom itself, but by the electron which it carries. It is during the accelerative period that radiation occurs. If the atom simply carries a charge along there is no radiation. There is nothing visible in the cathode rays as long as they are traveling with uniform speed and direction; it is when they are accelerated, started or stopped, or curved, that radiation occurs. The electron instead of simply vibrating might be revolving round the atom like a satellite; that would be centripetal acceleration, which is just as effective as longitudinal acceleration.

But if radiation is due to an orbital motion of an electric charge, it ought to be amenable to a magnetic field; every motion of an electron constitutes an electric current, and electric currents are amenable to a magnet. A source of light put between the poles of a magnet ought to show some difference. Faraday tried many experiments in this direction and failed, because the appliances available in his day would not show it. Nowadays, with a Rowland grating, the spectrum is much better defined, and a few years ago Zeeman, of Amsterdam, was able to see the difference when light is magnetized.

It often falls to men of genius to predict a great deal more than their generation can realize. A theory had been given by sundry people, including Fitzgerald, Larmor, Lorentz, and others. Perhaps the theory has been given more completely by Lorentz than by anyone else. It was an interesting case of prophetic prediction. They predicted that the effect observed by Zeeman would follow if light were due to revolving electrons. Time only permits me to indi-

* A lecture delivered at Bedford College for Women, on February 5, by Sir Oliver Lodge, F.R.S. Reported from shorthand notes.

cate the explanation. It comes near to astronomy, and, indeed, it had been worked out six years before by Dr. Johnstone Stoney on astronomical principles. He had fully worked out the perturbations, but had not suggested that they would be caused by a magnet. But Larmor and the others did. They perceived that on applying to an orbit or circular current a strong magnetic field, that orbit will tend to be deflected; the effect of a magnetic field in general is a deflecting force. But as the circulating electron has inertia, the application of a deflecting force will not make it simply obey the force that is applied, but will make it move sideways, like any planetary orbit or a spinning top. A precessional motion is set up. Anything spinning that has inertia does not obey the force but moves at right angles. Thus the revolving electron will not, when the force is applied immediately, set itself normal to the field, but will go round the magnetic lines in a precessional motion; and that precessional motion will analyze the original lines of the spectrum into three. (Here the lecturer gave an illustrative experiment, and proceeding, pointed out that when the polarization of the lines is examined, the vibrations are precisely as predicted.) It was further found that by the amount of separation of these lines a calculation could be made of what the magnitude of the electric charge was in relation to the inertia of the revolving portions of matter. It was thus found that the radiating particles have just the same inertia and just the same charge as the particles in the cathode rays. All the known phenomena connected with conduction and radiation are allied to these very small particles—the same inertia, the same electric charge, and the same kind of velocities, the mass being something like the thousandth part of a hydrogen atom.

Passing over chemical affinity and cohesion, the lecturer proceeded to discuss other phenomena which are due to these small particles. These particles, in order to give rise to visible radiation, revolve with terrific velocity. The number of vibrations which constitute visible light is from 400 to 800 million million times per second; and although it is no great distance round an atom, yet these particles have to go at very high speed; hence, naturally, some of them occasionally fly off. This will occur from various causes; they will fly off under the action of ultra-violet light, and so give rise to leakage of negative electricity. But there are certain substances which will emit these particles without any stimulus, and the first discovered was uranium. Although there may be aluminium or other screen between a piece of uranium and a photographic plate, something will penetrate through to the photographic plate. This constituted the discovery, by Becquerel, of the radio-activity of substances. In the researches of Dr. Russell various substances were found to possess this quality of giving out something on their own account. But the subject has gone ahead very far and fast. The most important developments have been made by Monsieur and Madame Curie in France, discovering polonium and radium, which latter has the properties possessed by uranium in a most extraordinary degree. The rays given off by these substances are of extraordinary interest; they have marvelous penetrating powers and are very intense, more intense than the X-rays given by a Röntgen tube. Radium rays will not only penetrate a foot of aluminium or wood, but they will penetrate three-eighths of an inch of lead, and then be as strong as are the rays from uranium. The full mechanism of the giving off of this great amount of radiation has still to be further investigated. It is a kind of electric evaporation, an emission of particles; this seems clear. There are three kinds of radiation: (1) particles which are readily stopped by obstacles, absorbable rays; (2) the particles which penetrate obstacles with singularly penetrating power; and (3) the ordinary X-rays. X-rays are waves in the ether, not light, something of that nature; the penetrating rays are electrons which are shot off. But the most interesting are the first rays, those which are easily stopped; for these turn out to be atoms of matter shot off with a speed comparable to that of light. It is the first time that matter has ever been known to have such a speed as that. Rutherford, now of Montreal, has measured for the first time the speed of these readily stopped absorbable particles, and also their mass. He shows that they are atoms of matter, and that they are moving with one-tenth of the velocity of light.

All hot bodies and all negatively charged bodies are now believed to be giving off these particles; radio-activity is becoming quite a common feature. Recently fallen rain-drops are radio-active, leaves of plants and most things in sunshine are radio-active; the difficulty will be to find something which is not radio-active in some degree, and the commonest kind of radio-activity appears to be the detachment of an electron. Loose charges seem to fly off, apparently by centrifugal force or the jostling of the atoms.

The size of electrons is known, on the hypothesis that the atom of matter is composed of them, i. e., on the hypothesis that the inertia of matter is electrical, or that it is electrically composed of the inertia of these charges. Evidence of this is accumulating, and there is reason to believe, not only on philosophical grounds, but in accordance with direct physical experiment, that electric inertia is the only inertia that exists. The size of an electron can then easily be determined. Regard the radius as unknown, the charge as known, the mass as known; then the size is at once calculable. The size of these electrons is about one hundred-thousandth part of the diameter of an atom, otherwise they would not have sufficient inertia. They are the smallest bodies known. There was a time when the atom felt small; it is not big, it is true, but it is getting to feel quite a large thing beside the electron. To illustrate the difference between an atom and an electron, imagine an electron to be the size of a full-stop as here printed, and an atom a church 160 feet long, 80 feet broad and 40 feet high—in an atom of hydrogen there are nearly 1,000 electrons—imagine those thousand full-stops thrown into that church, and some idea will be obtained of the relative sizes of the electron and the atom. The electrons occupy the atom very effectively; they are energetic and pushful, though not big. They occupy the atom in the sense that soldiers occupy a country, that is, they will not let anybody else in. The electrons, by the force they exert, will not let anything else in, they make the atom impenetrable; they also give the atom its other properties and enable it to act chemically. That chemical affinity is electrical force has been known for a long time; it was suspected by Sir Humphry Davy. I believe if the atom has no extra or odd electron it has no chemical force; the atom may have molecular force, which is cohesion, and this point might be explained at greater length; for in my ideas cohesion is turning out to be electrical too, though not in the sense of attraction between ordinary positive and negative electricity.

The relation of the electron to the atom is a matter of the most intense interest. But it is not to be supposed that the electron is stationary in the atom. The electrons are revolving round one another at tremendous speed, so that the atom is a region of intense activity. The electrons are not in the least crowded, although there are a thousand in the hydrogen atom, twenty or thirty thousand in the sodium atom and one hundred thousand in the mercury atom; for consider how far apart are they in proportion to their size. Just as far apart as planets in the solar system are in proportion to their size. The distance of the earth from the sun is to the size of the earth very much as the distance of electrons from each other is to their size in a mercury or platinum atom. The fact is, we come to an atomic astronomy, and the atom is becoming like a solar system, or like nebulæ or Saturn's rings or something of that kind, composed of a number of small particles in a violent state of revolving motion and occupying very little of the whole space with their actual substance. They are so small that collisions are infrequent. So it is in the solar system and heavens generally; collisions do occur, but seldom, because of the excessively small sizes compared with the distances at which they are spaced out.

Taking any family belonging to a sun, i. e., a solar system, it forms something like the same kind of collection as the electrons form in an atom. So when we get in an atom a sort of solar system we begin to question whether there is anything in absolute size at all. It is a question I cannot answer. It has been suggested that solar systems may be atoms of a still larger universe. These are questions that are too hard. But there appears to be no end to the infinity of the universe, and all that we can say is that the probability is that it is infinite in an infinite number of ways.

CONTEMPORARY ELECTRICAL SCIENCE.*

CHARGE ON THE ION.—H. A. Wilson has made a fresh determination of the charge on a Röntgen ray ion, and has found the value 3.1×10^{-10} electrostatic units. This agrees very well with Townsend's value 3×10^{-10} obtained by bubbling newly-prepared oxygen through water, and confirms Thomson's suspicion that the original value 6.5×10^{-10} was too high because the cloud was formed on negative ions only, and not on both kinds as was supposed. The method used depends upon the fact that the ions produced in air by Röntgen rays act as nuclei for the cloudy condensation of water vapor when supersaturation exceeding a definite amount is produced by a sudden expansion. The author used an expansion of about 16 cm. or 17 cm. of mercury, which produced condensation mainly on the negative ions. The cloud was produced between two horizontal brass discs, 0.5 cm. apart, which were given a difference of potential of 2,000 volts. The cloud fell with a certain velocity from which the diameter of the molecules could be calculated. This velocity was accelerated by the field. The majority of the molecules fell in 23.65 seconds without the field, and in 17.22 seconds with it. Some sets of nuclei fell more rapidly, probably because they contained more than one electron each, and some, which contained positive ions, fell much more slowly. The radius of a molecule of air comes out at 1.2×10^{-8} cm.—H. A. Wilson, Phil. Mag., April, 1903.

RADIO-ACTIVITY OF URANIUM.—E. Rutherford and F. Soddy have examined the process by which uranium loses and recovers its β-rays or negative electrons. Sir William Crookes showed in 1900 that uranium can be deprived of these rays by precipitating from an aqueous solution by means of ammonium carbonate and redissolving the pure uranium with an excess of the same reagent, which leaves the "Uranium X" as an insoluble residue. This "Uranium X" sends out deviable photographically active rays, but these diminish in intensity by about half in 22 days, and nearly disappear in 160 days. In exact proportion as the "Uranium X" loses these β-rays, the pure uranium recovers them and adds them to the non-deviable positive electrically active α-rays, which are unaffected by ammonium carbonate. It is just as if the power of emitting β-rays or negative electrons found its way back to its original abode within the pure uranium. Thus a supply of "Uranium X" may be chemically produced until the uranium is consumed, the total radiation remaining always the same. Thorium shows an exactly similar behavior, but its study is complicated by the presence of an "emanation" and by induced radio-activity. Both the increase and decrease of uranium radio-activity are in geometrical progression.—Rutherford and Soddy, Phil. Mag., April, 1903.

UNDAMPED WAVES IN WIRELESS TELEGRAPHY.—H. T. Simon and M. Reich point out that at the present we are only able to use successive trains of rapidly-damped oscillations, separated by comparatively long intervals. Hence it is at present impossible to emit waves capable of producing sharp resonance, such as the waves emitted by a tuning fork. The greatest progress is, however, bound up with this very problem, and if it were possible to emit a train of regular periodic oscillations of high frequency, the problems of syntony and of wireless telephony would soon be solved. They believe that the solution lies in the direction indicated by Duddell's singing arc (see the Electrician, vol. xlvi., pp. 269 and 310, 1900), where a continuous current is sent through an arc lamp in one branch circuit and a capacity and inductance in another branch circuit. The current breaks into sinusoidal waves whose frequency can be judged by the pitch of the note emitted by the arc. That frequency does not exceed 20,000 per second. But higher frequencies may be obtained by substituting a mercury lamp for the arc. The authors have succeeded in pushing the frequency as far as a million per second with an Arons lamp as modified by Hewitt. Better results would be obtained by a spark-gap in a vacuum fed with continuous current. The oscillations could be strongly damped and brought very close together, so as to constitute practically a sine discharge. The power required would be very high and would go into several thousand horse power for wireless telegraphy. But the results would be of corresponding value.—Simon and Reich, Physikal. Zeitschr., April 1, 1903.

SYNTONY IN WIRELESS TELEGRAPHY.—F. Braun describes an arrangement by which several independent wireless messages may be received simultaneously at the same station. It was devised primarily to reduce the height of the receiving antenna. The receiving wire, with the resonator in its center, is not stretched vertically, but slantingly in a plane containing the sending wire. The slant should be about 1 in 12. The E. M. F. induced in the resonator is only in proportion to the vertical height between the terminals, but as long as the horizontal projection of the wire can be practically identified with its length, the E. M. F. proceeding along the wire will always have equal phase with the ether wave passing over it, and resonance will take place. On turning the wire out of the sender plane by some 10 deg. there is no response. When the distances are such that the detector becomes uncertain, a displacement of 45 deg. may become necessary. The vertical height of the receiving antenna need not exceed about 5 meters. Another apparatus, due to the late Capt. von Sigsfeld, consists of two vertical wires of quarter wave-length, joined by a horizontal wire of half wave-length, with a coherer in the middle. On placing its plane across the line of propagation of the sender waves, it ceases to respond, but response is re-established by rotating the plane by some 10 deg.—F. Braun, Physikal. Zeitschr., April 1, 1903.

DISINTEGRATION OF PLATINUM METALS.—The disintegration of electrically-heated platinum and kindred metals in air puts a formidable difficulty in the way of their utilization for heating purposes. This is especially the case with iridium, which is otherwise the most suitable metal on account of its high melting point. With a view to meeting these difficulties, L. Holborn and L. Austin have made some measurements with the various metals at different pressures and temperatures and in various gases. These experiments brought out a characteristic difference between palladium and the other metals. The disintegration of palladium varies greatly with the pressure, but not with the nature of the gas. In platinum, iridium, and rhodium the reverse is the case. Thus, a sheet of platinum 1 mm. wide, 0.1 mm. thick and 75 mm. long loses 0.68 milligramme in half an hour in open air when heated to 1,500 deg., whereas in oxygen it loses 3.41 milligrammes and in nitrogen 0.05 milligramme under the same conditions. In rhodium the loss is about half that in platinum, but in iridium it is about twenty times as great. Palladium heated to 1,350 deg. loses 1 milligramme in open air or nitrogen, but the loss becomes 7.3 milligrammes on reducing the pressure to 25 mm. The authors suppose that palladium undergoes sublimation, while the other metals are subjected to some kind of chemical action.—Holborn and Austin, Sitzungsber. Akad. Berlin, 12, 1903.

CONDUCTIVITY IMPARTED TO A VACUUM.—O. W. Richardson has investigated the electric conductivity of the space surrounding hot surfaces of platinum, carbon and sodium at low pressures. The experiments show that the negative leak from hot wires at low pressures is a definite function of the temperature of the wire, and increases very rapidly as the temperature is raised. The author accepts the theory that a metal contains a very great number of free electrons, whose mean free path is comparable with that of a molecule in air at atmospheric pressure. The electrons must, therefore, be moving with a distribution of velocity given by the Boltzmann-Maxwell law. Since the electrons do not escape from the metal at ordinary temperatures, it is evident that there must be a discontinuity of potential at the surface which prevents their escape. On raising the temperature of the metal, the energy of the electrons is increased, and at high enough temperatures some of them will be able to shoot through the surface into the surrounding space. The number of free electrons in a cubic centimeter of platinum comes out as 10^{21}, which is in good agreement with Patterson's value 10^{22}. The discontinuity of potential at the surface of the conductor is 2.45 volts for sodium, 4.1 for platinum and 6.1 for carbon. These numbers are inversely proportional to the cube roots of the respective atomic volumes. Hence, the work required to force an electron out of a metal varies inversely as the average distance between neighboring atoms. The biggest leak observed was 2 amperes per square centimeter of a carbon surface maintained at —60 volts, with a pressure of 1-600 mm. If the gas produced this current by interaction with the carbon, each gaseous molecule would have to liberate 25 ions at each impact, which is highly improbable.—O. W. Richardson, Proc. Roy. Soc., March 26, 1903.

ROTATING CATHODES.—The rotating cathode has been applied usefully in the arts for the purpose of securing compact metallic deposits in electro-plating. F. A. Gooch and H. E. Medway have employed the same device in analytical separations in which the object is to remove the metal completely from solution. They attempted thus to avoid the interfering action of hydrogen, which, as a rule, prevents the employment of high current densities. They succeeded in producing with strong currents and in a short time deposits sufficiently adherent and homogeneous for analytical purposes. The cathode consisted of an ordinary 20 cu. cm. platinum crucible rotating at a speed of some 700 revs. per min., and driven by a small electric motor having a vertical shaft. The crucible is mounted on a piece of rubber stopper passed over the shaft. Metallic connection with the shaft is secured by a piece

* Compiled by E. E. Fournier d'Albe in the Electrician.

of platinum foil soldered to the shaft and passing over the rubber stopper, so as to secure a good contact when the crucible is pressed on. Dilute sulphuric acid is used for the solution, since copper deposits more quickly so than from a nitric acid solution. Nickel and silver may also be completely and rapidly deposited by the same process.—Gooch and Medway, American Jour. Science, April, 1903.

THE ZONE OF THE LITTLE PLANETS OR ASTEROIDS.

SINCE the opening years of the twentieth century seem to be, far and wide, devoted to the celebration of momentous events which took place a hundred years or more ago, it may not be amiss to recall an occurrence that happened a trifle over five score years since, or just upon the dawning of the nineteenth century, and which is accordingly eligible for an appropriate centennial celebration.

True, without having any far-reaching effect upon the earth-dwellers in general, it was still an event momentous in itself; because it did not fail to leave its mark upon the scientific world, first, by establishing the correctness of a much-discussed theory, and again, by filling up an important gap in the row of planets belonging to the solar system.

Intently gazing out through the dome of the observatory at Palermo, on the night of January 1, 1801, Piazzi discovered the first of the minute planets known to us under the name "asteroids." What was, till then, apparently a void or unfilled space, is now, including the most recent additions, occupied by little bodies of varying size to the number of 480. The modern methods of discovery, which make use of the sensitized photographic plate—a searcher far more sensitive and indefatigable than the human eye, even when aided by the most perfect optical instruments, could ever hope to be—have, in the last decade, added so many new members to this coterie of wanderers between Mars and Jupiter, that, in comparison, the older method of individual search and mapping out upon a celestial chart seems to be a hopeless task.

Out of this mass of planetoids, by a study of the peculiarities of their orbits, certain laws have been evolved which, for the most part, are only interesting to the professional astronomer.

There are some deductions, however, which are of interest to the layman because they materially assist him to comprehend some of the opinions held concerning the relationship between the bodies composing the solar system.

In the figures which express the relative distances of the heavenly bodies from the central object of our system, the sun, there is known to exist an approximately progressive series of which use may be made to impress upon the mind the ratio prevailing between the distances themselves. The discovery of this succession of numbers has been attributed to Titius, the mathematician of Wittenberg, as well as also to the scientist Wurm, or even Bode; but to neither of them is due the honor. Moreover, it has erroneously been dignified as a "law," which it by no means is.

This interesting series, then, consists of the numbers 0, 3, 6, 12, 24, 48, 96, 192. By placing them in a row and adding 4 to each of them, we obtain the series indicated by the numbers 4, 7, 10, 16, 28, 52, 100, 196, which series pretty correctly expresses the distances from the sun of Mercury, Venus, Earth, Mars, the asteroids, Jupiter, Saturn, and Neptune.

The manner in which the former series is constructed is easy to discover. First select the numbers 0 and 3 and each following number in the series is the double of the one immediately preceding it. If, according to the second series, to which the increment 4 has been arbitrarily added, we express the distance of the earth from the sun in 10 parts of any given quantity, the distance of Mercury will then be expressed by 4 parts of the same given quantity, Mars by 16, and so forth to the end of the system. The distances of the many asteroids may accordingly be given as 28. This series, which indicates the mean distances of all these bodies from the sun, if not exactly, was nevertheless known to a certain degree of approximation very many years before the little planets were discovered, and this knowledge led to the theory that a body of some sort ought to be found filling the void in the planetary system between Mars and Jupiter. As it has since developed, the single theoretical planet of requisite size to account for the perturbations in the movements of Mars and Jupiter, and which the astronomers fully expected to find in that void, has turned out to be not one, but nearly half a thousand small, even minute, bodies, and their number is increasing from year to year. They are, moreover, not evenly distributed throughout the vast space between Mars and Jupiter, in which they revolve in their elliptical orbits, but are subdivided into three separate groups. The Mars group, meaning those which circulate nearest to Mars, contains 108 asteroids; the chief, or centrally independent, group contains 350; and the group which approaches more nearly to Jupiter and remains, so to speak, within his sphere of influence, contains only 18 bodies thus far discovered.

As to magnitude and brilliancy, these planetoids differ greatly also among themselves. It is very probable—indeed it may be safely affirmed—that a large number of these insignificant planets have not yet been discovered, yet those of them which have till now escaped the eye of the astronomer must, for the most part, be of very low brilliancy, and at least smaller than stars of a magnitude equal to 10½.

Of the number already charted, the greater part are extremely small, more than half of them having diameters less than 80 kilometers (50 miles) in extent. About 200 have diameters varying from 80 to 160 kilometers (50 to 100 miles); 41 from 160 to 240 kilometers (100 to 150 miles); and finally the 12 largest ones, whose diameters exceed 240 kilometers. The queen of the constellation, Vesta, measures 834 kilometers (518 miles) between poles, and is closely followed by Ceres, with a diameter of 772 kilometers (480 miles), Pallas with a diameter of 584 kilometers (362 miles), Hydica, with one of 346 kilometers (215 miles), and so on down a row of successively diminishing planetoids such as Eunomia, Juno, Amphitrite, Psyche, Dembrowska, Kalliope, Iris, and Metis. The above-named dozen largest of the planetoids, having diameters exceeding 240 kilometers, contain about two-thirds of the combined mass of the asteroid rings, which, according to calculation, would form a sphere having a diameter of about 1,320 kilometers (820 miles), and a cubic content of about 1-900 of that of the earth.

Assuming the mean density of the asteroids to be about two-thirds that of the earth's density, then the whole mass of these little planets would form, combined, about 1-1350 part of the earth's mass, or only about 1-17 part of the moon. Of these wanderers, the smallest, and those discernible chiefly by means of the photographic plate, are frequently the most remarkable. Eros, for example, possesses a diameter of only 32 kilometers (19.8 miles), and yet he has for some years back been a source of no little interest to astronomers all over the world, causing the fitting out of many expeditions for visiting the most favorable localities for his unobstructed observation. The photographic objectives of the present day are constructed with such a degree of perfection that they focus upon the plate the light gathered from asteroids the diameters of which measure between 10 and 20 kilometers (6.21 and 12.42 miles).

With further progress in the size and collecting power of these lenses, we must eventually be almost able to see grains of cosmic dust, and our thoughts wander to that spirit of the univèrse, a disciple of Laplace, who, finding himself in possession of the knowledge of all the processes of nature, and by the aid of Dubois-Reymond's "Grenzen des Naturerkennens" (limit of natural science), has become popular throughout the scientific world. The powers of the 300 astronomical observatories in the world, great and small, are of course not yet sufficient to bring our knowledge to such a state of perfection.—Translated from Allgemeines Journal der Uhrmacherkunst.

Gold may usually be bought in the Central and South American republics at considerably below its assay value. Most of the placer gold is worth from $17 to $19 per ounce and can usually be purchased at $11 to $12 per ounce in native silver money. As American exchange is only about 50 cents on the dollar, one can practically buy gold dust for about $5 an ounce, but the amount of gold thus obtainable is so small at any one place as to render it inadvisable to undertake any expense in the matter. The most of the gold offered for sale is bought up by the merchants and travelers who chance to learn of the whereabouts of the gold. In Colombia, S. A., platinum is also found with the gold—nuggets weighing as high as 14 ounces having been discovered recently. The value of native platinum varies greatly from $3 or $4 to about $20 per ounce, according to the purity of the grains.—Mining and Scientific Press.

"LA STROBEIKA PERSANE."*

THIS illusion, made popular a few years ago by the late A. Herrmann, under the name of "Strobeika" was originally produced at Houdin's Little Hall, in Paris, by the inventors of it, two Germans, Herren Lutz and Markgraf.

The trick is supposed to take place in a prison or dungeon. In the center of the stage, quite near the back scene, stand four upright posts about eight feet high, and set about eight feet apart on the long side, and four on the short. These posts are made fast to a rectangular iron frame at the top, from the four corners of which are chains supporting a plank about

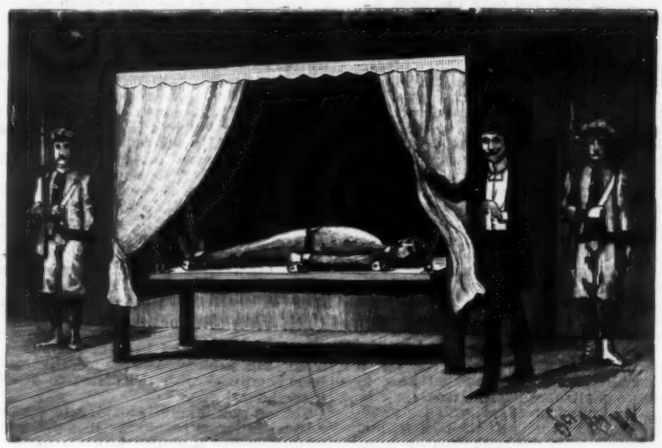


FIG. 1.—"LA STROBEIKA PERSANE."

an inch and a quarter thick, all in full view of the audience. Curtains hang from the framework to about a foot below the level of the board; these curtains can be opened or closed by sliding them back and forth on the frame, rings being sewed on them to allow of this being done easily. A man supposed to be a prisoner is stretched upon the plank; his wrists and ankles are manacled and locked by a committee from the audience, who can furnish, if they desire, locks of their own. His neck is also inclosed in a steel collar and locked to the plank. At a signal the curtains are closed, and, as they reach only a little way below the plank, permit of a full view underneath to the rear wall of the stage. In less than a minute the curtains are withdrawn again, and a young lady is seen to have taken the place of the man, who, at the instant of the girl's discovery, is seen running down the aisle of the theater. Now, let us see how this strange trick is accomplished.

The first thing is the explanation of how the man becomes released from the shackles. It principally lies in the construction of the board. There is no deception about the keys, locks, or manacles, since it is not at all necessary to the deception that there should be. The board is hollow and contains cunningly concealed levers, four in number, which move simultaneously. The eyes that the manacles slip over, and to which the locks are fastened, go into the board and are held fast by the ends of these levers, which enter a hole or notch, as the case may be, in the eye. The shackles and neck piece and their respective eyes are all made

FIG. 2.—TOP OF BOARD, SHOWING LOCKS AND HASPS.

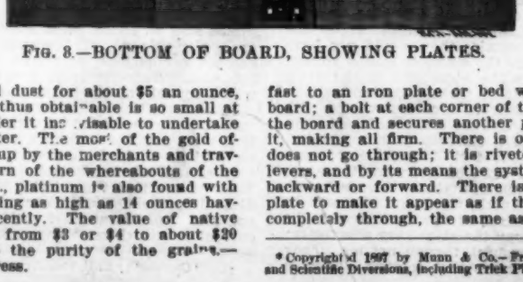


FIG. 3.—BOTTOM OF BOARD, SHOWING PLATES.

fast to an iron plate or bed which is bolted to the board; a bolt at each corner of the plates goes through the board and secures another plate at the bottom of it, making all firm. There is one bolt, however, that does not go through; it is riveted to one of the short levers, and by its means the system of levers is pushed backward or forward. There is a nut on the bottom plate to make it appear as if this identical bolt went completely through, the same as the others. The lev-

* Copyrighted 1897 by Munn & Co.—From "Magic, Stage Illusions and Scientific Diversions, including Trick Photography."

ers run in grooves made in any suitable part of the board and covered by a strip of wood or other material, thus rendering the mechanism invisible, and appearing as if the board was solid.

At each corner of the board is a ring or screw eye, into which the chain provided with a hook is secured, by which to suspend the board. The four levers are pivoted to a rocking lever in the center of the board, which is likewise pivoted. By this means all the levers are moved simultaneously. When the lever is moved it releases all the shackles, and the prisoner is then, of course, free, and it is but the work of a moment to climb out through an opening in the scene at the back, where the lady who is to take his place is now waiting on the end of a long board pushed out through the opening in the scene. The lady gets on the trick board, the man slams the shackles into place, moves the bolt back, thus shoving the levers back into their notches in the eyes, again making everything fast, makes his escape through the scene, and appears a minute later from the front of the theater.

The trick is varied sometimes by using double curtains at the back; concealed between them is the lady. After the exchange the man hides in the same place, and another man, his exact counterpart, is the one who makes his appearance in the audience.

HOW TO TELL A DIAMOND AND APPRAISE ITS VALUE.

As a usual thing, an expert in precious stones can easily distinguish a real diamond from an imitation by the naked eye alone; with the aid of a magnifying glass this distinction becomes a certainty beyond all peradventure.

Instances have occurred, however, where the cleverest of the clever have been at fault; such a case happened not long since at the Hotel Druout at Paris, where an extensive sale of diamonds and other stones was in progress.

"A magnificent diamond," exclaimed the auctioneer, holding up a sparkling stone. "One of the most beautiful pieces of crystallized carbon in existence. Now, gentlemen, what am I offered for it? I shall start it myself at the ridiculously low figure of 25,000 francs." Twenty-six thousand was heard; 28,000 came from another part of the anxious crowd. "Thirty thousand," cried another, in feverish excitement. Some one else raised this bid to 35,000, to be followed by a sharp and snappy bid of 40,000. There was a lull; the bidding had apparently reached its climax; buyers were considering the cost.

"Come, gentlemen, don't stop there," urged the auctioneer; "this stone is worth much more, and there is not a person present who does not know it." With some hesitation one of the buyers bid 42,000 francs. "I beg your pardon," interrupted a well-known merchant, an Armenian millionaire, "would you mind letting me have a look at the stone?"

"Certainly not," exclaimed the auctioneer; and the diamond expert proceeded to confide the precious stone to the Armenian's care. "Forty-two thousand francs," continued the auctioneer. "Once! Forty-two thousand twice! Do I hear any more? Forty-two thousand three times!" "This stone is false!" suddenly cried the Armenian.

A painful silence followed, but for a moment only. The expert then, furiously throwing himself upon the Armenian, shrieked, "What did you say, sir? What did you say?" "I said the stone is false, and so it is." "You are a fool!" he shouted. "I am an expert in diamonds, and I have passed upon it." "All that may very well be," coolly responded the merchant, "but I repeat that it is false just the same, and I am willing to back my opinion with money. Here is my cheque for one million francs; it is yours if the stone is a genuine diamond. For the rest," continued the Armenian, "the best proof is right at hand;" and drawing from his pocket a file he gave the stone a dry scratch and it fell into pieces. It was of glass!

The common test for diamonds is the fine, hard, jeweler's file; upon the surface of a true diamond it does not take hold, but easily scratches any imitation which has yet been made.

There are, besides diamonds, other products of Nature's laboratory which this file will not touch; for in grading the stones, which from their beauty and rarity we call precious, we arrange them according to their hardness. The diamond being the hardest occupies the commanding position. Apart from the ability of the other stones to resist abrasion, they possess certain characteristics of color and evince other phenomena which differentiate them easily from the queen of the gems.

These statements need confirmation, the reader will say. Granted; and we shall give a series of proofs, of which the skeptic may take his choice and employ the test which lies nearest within his reach. To the layman, who knows nothing of the jeweler's file, the simple process of scratching glass, though far from conclusive, is always accessible and ever uppermost in his mind.

That both men and women, as soon as they become possessors of this delight-giving jewel, proceed to test its powers in this direction is evidenced by the condition of some of the large sheets of plate glass along the public streets, the window panes in private houses or in other more secluded public places. Having the power to mar in this fashion seems to add value to the possession of the stone, which power, when unobserved opportunity offers, he or she proceeds to exercise, enjoying the certain satisfaction that because the stone still scratches glass it must of necessity be diamond. As we say above, this is not conclusive.

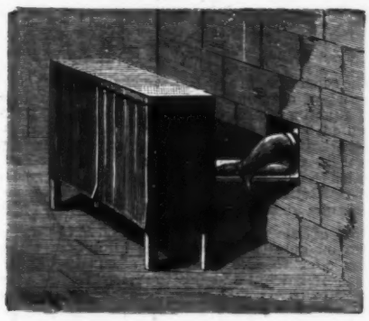


FIG. 8.—THE ESCAPE OF THE PRISONER.

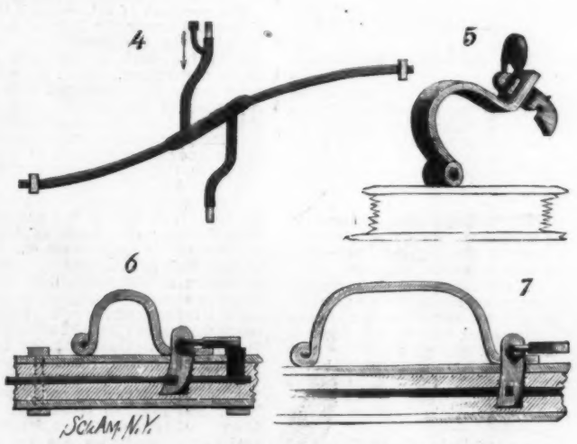
Scratching glass and cutting glass are, however, not synonymous.

A diamond will, with little pressure, cut through the outer skin of glass as no other stone will, and with a light and well-directed tap the sheet will fall apart. Other substances, stones and manufactured articles, will scratch glass, and deeply too, but when it comes to the final separation of the parts, it is a different matter.

It is known, for instance, that, with the stubs of the common electric light carbon lying so profusely about our best lit streets, glass may be scratched if one is so fortunate as to run across an exceptionally hard piece; and though these are indeed pure carbon or nearly so, they are a long way from being diamonds. There are some imitation diamonds too which will scratch glass, but there the similarity ends, for you cannot separate the piece upon the scratched line.

For an eye practised in comparisons it is not difficult to discern that the facets in the cut of a true diamond are not as regular as are those of the imitation; for in cutting and polishing the real sparkler an effort is made to preserve the original stone as much as possible, preferring some slight irregularities in the planes and edges to the loss in the weight, for we all know that diamonds are sold by weight. In an imitation, however, whether of paste or another less valuable stone, there is always an abundance of cheap material which may be cut away and thereby form a perfect-appearing stone. Another simple experiment, and one which may be tried without the danger of marring valuable property, is the drop of water test. If you place upon the table of a brilliant a very small drop of water, and with the point of a needle or pin try to lead it about over the surface, it will preserve its globular form if the stone has been previously made dry and clean. In this same experiment with a piece of glass upon which the like care has been expended, the drop will spread. Again, a diamond dropped in a glass of water will be distinctly visible and will shine out whitely through the liquid, whereas an imitation will blend with the water and become almost lost to view.

If a black point, such as the dot over an *i*, be made upon a piece of white paper and regarded through a diamond by means of a magnifying glass, the dot will be seen clear and clean; should an imitation stone be interposed, several points will be seen or the point present a fractured appearance, owing to the unequal refraction of the imitation.



FIGS. 4 TO 7.—DETAILS OF THE MECHANISM.

Hydrofluoric acid, which can only be preserved in vessels of gutta percha, will dissolve all imitations, while it has no effect whatever upon a genuine diamond. Take a bit of stuff with red and white markings, pass the stone to be tested over it, and closely observe the result. If the stone be an imitation, the colors will be easily distinguishable through it; if it be a diamond, no difference of color will be appreciable.

A genuine diamond, rubbed upon wood or metal, after having been previously subjected to the rays of the electric arc, becomes phosphorescent in the dark; this cannot be said of any of the imitations. If the stone to be tried be covered with borax paste, and after being well heated in the alcohol flame, dropped into a glass of water, the proof will be instantaneous. The glass imitation will fly into bits, while the genuine stone will not be disturbed by the ordeal. Finally, try to crush between two hard plates a diamond and an imitation, and learn the difference.

As we have intimated above, the effort to imitate the priceless gem is not confined to the productions of the human hand. Nature herself supplies stones of sufficient value to be called precious, but of a less degree of hardness and of correspondingly less value, such as the sapphire and the topaz, which some disreputable merchants try to palm off on the unwary, especially when the weakness of their color allows them to approach very near to pure white. After the diamond the sapphire is the hardest stone; with her more beautiful sister she possesses also the quality of resisting the attack of the file, but she is, however, cloudy in appearance and of a milky hue. The topaz is slightly yellowish, and surrenders to the cutting teeth of the file. There are a great number of white diamonds, but a pure, clear, transparent stone without a shade of color is more rare than is often supposed.

Besides white diamonds there are some which exhibit the shades of red, blue, green, yellow, brown, black, and pink. Heat sometimes causes a diamond to change its color, and after a time the color thus acquired becomes permanent. Yellow diamonds, or those commonly denominated "off color," furnish the greatest variety of shades, and some of them exceed in beauty all other stones of that color. Specimens of canary-colored diamonds are by no means rare. They may almost be said to be common. A pink or rose-colored diamond is of great value; and the red diamond, surpassing the ruby in its magnificent coloring, is considered the most beautiful of all the precious stones, being exceedingly rare. The one bought by Paul, Czar of Russia, weighed ten carats and cost him two and one-half million francs. A perfectly black diamond is almost as rare as a red one. For beauty the blue stones come directly after the red diamonds. Those possessing the deep blue, and in this respect resembling the sapphire, are indeed most beautiful gems, differing from the sapphire only in quality and by the magnificent fiery colors peculiar to the diamond. The only true blue diamonds come from the mines in India. The varieties of green are not so rare as the blues, reds, blacks, and pinks, but those of a grass green hue like the beautiful emerald are seldom found. Where they do exist, however, they surpass in brilliancy the finest emerald. There are several specimens of green-tinted diamonds in the Museum of Natural History at Paris, but the best-known specimen is safely guarded among the Saxon treasures at Dresden, where it is considered one of the five wonders of the world as regards stones.

In place of the Brazilian diamond, which of late years has become quite scarce, Cape diamonds of much inferior value and brilliancy are often sold. To be able to distinguish between these gems is an accomplishment possessed by the few.

In his studies upon the curious phenomenon of the phosphorescence of the diamond, Mr. Gustave Le Bon discovered a new method, and he claims a sure one, of differentiating these two gems. In effect he has proven that all Brazilian diamonds, after being exposed to the light of a burning strip of magnesium, became highly phosphorescent, while the Cape diamond either did not phosphoresce at all or displayed very weak inclinations that way.

Two principal factors determine the value of a diamond—its beauty and its thickness. Its beauty depends on its limpidity or sparkling transparency, "on its water" in technical parlance, on its color—the nearer it approaches to a steel-white the better—and on its cut; all these qualities conduce to its brilliancy.

Its thickness reflects upon its weight, of course, which is measured by a peculiar unit called a *carat*, sometimes spelled *karat* and always signified by *K.* or *Kt.*, from *kouare*, a seed of a bush growing in India, that, because of its characteristic of invariable weight, has, from time immemorial we might almost say, served as the medium for weighing diamonds.

This carat weighs a trifle more than one-fifth of a gramme; to be exact, it weighs just 205 milligrammes, or about 3.2 grains. Small as it is, it is nevertheless subdivided into halves, quarters, eighths, sixteenths, thirty-seconds, and even sixty-fourths. Hence we often see a diamond described on a card as weighing 1, ½, 1-16, 1-32, instead of 1 19-32 K.; which goes to show with what exactitude the commercial weight of the diamond is calculated.

Stones of less than 5 K. are called current stones, those above 5 K., not exceeding 20 K., are large diamonds, and those over 20 K. are exceptional.

Defects in diamonds, which detract from their value, beyond color and cut, this latter referring to the manner or style of the cut, whether it be even or uneven, brilliant or rose, consist, mostly, of splits or striæ and deposits of foreign matter, all known under the collective term *blemishes* or *flaws*.

Again, there is a certain class of diamonds, called "smoked" diamonds, which present an inexplicable phenomenon. A few days after their liberation from the diamondiferous clay matrix, certain important changes take place in their internal construction; fissures begin to form, and finally they burst asunder, falling in pieces. For this reason the miners who find them hasten with all speed to dispose of them while they are in their primitive condition.—Translated from L'Almanach de l'Horlogerie et de la Bijouterie for the SCIENTIFIC AMERICAN SUPPLEMENT.

GREEK PAINTING IN THE ALEXANDRIAN PERIOD.

ACCORDING to Quintilian there were several famous painters in Greece about the time of Alexander the Great. He mentions Protogenes was distinguished for high finish, Pamphilus and Melanthius for composition, Antiphilus for facility, Theon of Samos for his prolific fancy, and for grace Apelles was unrivaled; Euphranor was in all things excellent, Pausias and Nicias were remarkable for chiaroscuro of various kinds, Nicomachus was celebrated for a bold and rapid pencil, and his brother Aristides surpassed all in the depth of expression. There were also other painters of great celebrity during this period: Philoxenus of Eretria, Asclepiodorus of Athens, Athenion of Maronea, Echion, Cydias, Philochares, Theomnestus, Pyreicus, etc. This general revolution in the theories and practice of painting appears to have been greatly owing to the principles taught by Eupompus at Sicyon, who advised that nature should be preferred to any artist. Pamphilus of Amphipolis succeeded Eupompus in the school of Sicyon, which from that time became the most celebrated school of art in Greece. Pamphilus had the reputation of being the most scientific artist of his time; and such was his authority, says Pliny, that chiefly through his influence, first in Sicyon, then throughout all Greece, noble youths were taught the art of drawing before all others. It was considered among the first of liberal arts, and was practised exclusively by the free-born, for there was an especial edict prohibiting slaves from exercising it. The course of study in this school occupied ten years, and the fee of admission was an Attic talent; Pliny mentions that Apelles and Melanthius both paid this fee. Apelles studied under Ephorus of Ephesus before he became the pupil of Pamphilus; Pausias also studied encaustic under Pamphilus. The course of study comprehended instruction in drawing, arithmetic, geometry, anatomy, and painting in all its branches. Pamphilus was the first painter, says Pliny, who was skilled in all the sciences, particularly arithmetic and geometry, without which he denied that art could be perfected. By these sciences as applied to painting, we must probably understand those principles of proportion and motion which can be reduced to rule: by arithmetic the system of the construction and the proportions of the parts of the human body; by geometry, perspective and the laws of motion, that is, so much of them as is necessary to give a correct representation of and a proper balance to the figure. Pamphilus seems to have painted but few pictures, but they were all conspicuous for beauty of composition. Nicomachus of Thebes was, according to Pliny, the most rapid painter of his time, but he was as conspicuous for the force and power of his pencil as for its rapidity. Plutarch compares his paintings with the verses of Homer. Nicomachus had many scholars, of whom Philoxenus of Eretria was celebrated as a painter of battles; a battle of Alexander and Darius, by him, is mentioned by Pliny as one of the most celebrated paintings of antiquity, but they were all surpassed by his own brother Aristides, who appears to have been the greatest master of expression among the Greeks.—The Architect and Contract Reporter.

THE ZEBRULA VS. THE MULE.

GERMAN papers say the mule will probably be replaced in the twentieth century by a more efficient animal, as it has been demonstrated that the mule, the cross between horse and donkey, is inferior to the cross between horse and zebra.

Formerly the opinion prevailed that the zebra was almost extinct. The opening of Africa, particularly the eastern part, reveals these fine animals in large numbers.

Compared with horses and cattle, they possess peculiar advantages, as they are immune against the very dangerous horse disease of Africa and also against the deathly "tsetse" fly. The question was therefore raised whether the zebra could not take the place of the mule, commonly used in the tropics. The greatest credit with reference to the solution of this problem is due to Prof. Cossar Ewart, who has been trying since 1895 to produce crosses between horses and zebras, with a view to developing an animal superior in every respect to the mule.

Three species of zebras still exist in Africa: the so-called "Grevy" zebra, on the high plateaus of Schoa; the common or mountain zebra, formerly found everywhere in South Africa; and the "Burchell" zebra, still frequently found.

Prof. Ewart produced crosses from mares of different breeds and zebra stallions of the Burchell kind. The offspring is called zebrula, and on account of its form and general bodily condition—especially the hardness of the hoofs—is specially adapted for all transport work heretofore performed by mules. The zebrula is much livelier than the mule and at least as intelligent.

The Indian government has already experimented with zebrulas for transporting mountain artillery at Quetta.

In Germany much interest in this animal is manifested. The well-known Hagenbeck is experimenting in this direction and intends to introduce the zebrula into Germany and America. The zoological garden at Berlin possesses some very fine specimens. The zebra stripes are often well preserved, while the undertone of the skin is generally that of the mother. A full-grown zebrula is 14 hands high and the girdle circumference about 160 centimeters (63 inches).

The experiments so far have been so successful that it is predicted that the zebrula during the present century will completely supersede the mule.

Some interesting details are to hand regarding the recent run made by the "Kearsarge" across the Atlantic. This vessel steamed 2,885 nautical miles in nine days, four hours and thirty minutes, making an average speed of 13.10 knots. She experienced variable winds of from three to eight in value. She slowed down for four hours on account of taking seas over her turrets, and she slowed to 10 knots for ten and a half hours on account of fogs and icebergs. She consumed 1,148 tons of coal—a daily average of 125½ tons for all purposes. It may be added that in fifty-three days she ran 8,200 miles, and was twenty-four days in port. There was not the least sign of breakdown in any part of her machinery.

ELECTRICAL NOTES.

In a paper recently published in the Elektrotechnische Zeitschrift, Dr. L. Finzi points out the necessity of calculating separately the different losses by friction in electrical machines, the item corresponding to brush friction being the only one so far duly dealt with, whereas the air and bearing frictions are, as a rule, considered jointly, assuming the former to be only a few per cent of the aggregate friction. After showing that this hypothesis is far from being generally true, the author describes some methods of separating both effects. As the effect of bearing friction is inversely proportional to the temperature of the bearings, whereas that of air friction is, of course, independent of that temperature, the total loss by friction, deducting the item due to brush friction, may be represented by an equation of the form

$$R_{(t)} = a - \frac{b}{t}$$

Both constants are easily determined by combining a series of observations and either solving systems of two equations each or drawing the straight line represented by the equation. A simpler method is based on the hypothesis that the resistance of air is proportional to the square of the speed, the coefficient of friction being proportional to the square root of the latter. Both methods may be used jointly, so as to check one another. A. G.

One of the objections to the erection of electric wires on poles in cities is the hindrance which such wires offer to free access to a burning building by means of ladders and fire towers. It is at times also necessary to cut such wires to afford access to a burning building—a work which is not highly appreciated by the fire-fighters. Another difficulty presents itself also, namely, the danger to the firemen from electric shocks due to currents carried to the nozzle by the stream of water when it comes in contact with live wires. Such shocks have more than once been of sufficient strength to disable firemen for a time, but, so far as is known, no fatalities due to this cause have occurred. In order to ascertain to what extent firemen are subject to risk of life, if at all, when the stream of water thrown from the hose strikes against live wires, a series of experiments were recently undertaken in Germany. They were made with pressures of 6,000 volts alternating current, and 550 volts direct current. The stream of water was directed against a portion of the wires from which the insulation had been previously removed. With the 6,000 volts pressure it was found that the resistance of about one foot of ordinary hydrant water reduced the potential of the current to a point where it was not dangerous, but the effects were not pleasant. When the resistance of the water was lowered by the addition of 0.05 per cent of soda, the minimum safe length of the stream was increased to about 40 inches. With 550 volts direct current a dangerous voltage was not reached with pure hydrant water, but with the same percentage of soda in the water harmful potentials were indicated by the voltmeters used in the tests when the stream of water was only 3 inches long. On the whole the results of the experiments showed that the danger to firemen from the contact of water from the hose with live wires carrying high potentials is not ordinarily so great as has been generally supposed hitherto. This, however, is no reason for lessening the precautions looking to the safety and best interests of all concerned in this matter.—Cassier's Magazine.

Individual rays independent of the radiation of a radio-active substance are found to expand, taking a fan-like shape, on being subjected to either magnetic or electrostatic deviation, giving evidence of the complex and heterogeneous composition of the rays, which must be made up of elemental rays of various deviabilities. Combining the electric and magnetic effects in a most ingenious way, W. Kaufmann, some time ago, was able to determine both the velocity and ratio $\frac{\varepsilon}{\mu}$ (ε being the electrostatic charge and μ the mass of the electron) for the particles moving in different classes of deviable rays. The result obtained proved that this ratio is highly dependent on the velocity of the rays, decreasing to a considerable extent, as the velocity approaches that of light. This diminution, as pointed out by H. Starke in a paper recently read before the German Physical Society, Berlin, is to be ascribed to an increase in the mass of the particles, the inertia of the electron moving along in radium-rays, being due wholly or partly to a mass of electrodynamical origin, i. e., different from ordinary, mechanical mass. The particles possess this mass in virtue of their charge, and as the electromagnetical energy evolved by a moving charge depends on the speed of the latter, a change in the velocity of the movement will be accompanied by a corresponding change of energy, as in the case of a material particle. Mr. M. Abraham, in his theory of the moving electron, arrives at the result that the product of the ratio $\frac{\varepsilon}{\mu}$ by a certain function $\psi(\beta)$ must be constant, if the particle is wholly devoid of "material" mass, its inertia being due to an electromagnetical field. The author has extended the range of these experiments to the higher speeds of electrons, as met with in the case of cathode rays. As in the range so far investigated, no material variation was observed in the magnitude of the ratio $\frac{\varepsilon}{\mu}$ — higher speeds, corresponding with higher discharge potentials, were to be obtained. Though a series drawback was opposed by the discharges losing their continuous character above 38,000 volts, their constancy was confirmed; for the rays examined accord with the hypothesis of a purely electrodynamical nature of the mass of electrons. A. G.

ENGINEERING NOTES.

Some experiments were recently carried out in Austria on the relative heating value of gasoline and denatured alcohol. For motive purposes a pair of nominal 8-horsepower engines, one designed for alcohol and one for gasoline, were compared. The gasoline had a specific gravity of 0.7 and a calorific value of 7,700 calories per liter; the consumption per horse power was 340 grammes. The alcohol was of 90 per cent strength and had a calorific value of 4,900 calories per liter; its consumption was 373.5 grammes per horse-power hour. The efficiencies were, therefore, 16.5 per cent for gasoline and 28 per cent for the alcohol.

A difficult engineering problem has presented itself in the construction of that portion of the Metropolitan Underground Railway in Paris which lies under the Place de l'Opera, says the Western Electrician. At this point three lines of the electric railway will cross one over the other at three different levels. The presence of water in the sub-soil near the surface renders the construction of the tunnels extremely difficult, and the engineers have solved the problem, according to report, in a somewhat paradoxical way. Large cavities, about 70 feet deep, will be dug in the earth and these filled with great blocks of cement, forming a solid, watertight mass. Then the engineers will commence boring their tunnels through the artificial rock sunk by themselves.

The French navy have been carrying out some daring gunnery experiments at Brest with the turret of the "Suffren" to ascertain the effect which would be produced by a heavy shot striking it. The turret shelters two guns of 305 mm. bore, and the steel armor plating is 26 cm. thick. To prevent its being injured the turret was coated with additional armor plating. The whole of the crew of the "Suffren" remained on board while the shots were fired from the "Masséna" with one of her heaviest guns of 305 mm. bore. The charge of powder was reduced so as to make the shot equal to that which would be produced with a normal charge from a distance of about 1,500 m. According to the Paris correspondent of the Standard, the turret was struck full by the first shot, and after the effects had been carefully examined, a second shot was fired. The shell was shattered against the armor plating, and a portion of it, weighing several kilogrammes, bounded back to the deck of the "Masséna," where it did some damage, without, however, injuring anyone on board.

In a recent issue of the Engineering Record, some interesting particulars of the equipment necessary in survey work in very cold localities are given by E. H. Drury. Mr. Drury states that both survey and construction are possible even with the thermometer 40 deg. below zero. If the weather is clear, the men do not mind the cold, and work well. In open country horses are used for transport, but in bush land men and dogs must do the hauling. The latter have been used almost exclusively in making the recent surveys for the Algoma, Central & Hudson Bay Railway. The party consisted of 22 men, who were accommodated in five 14 by 15 foot tents made of 10-ounce duck, and each furnished with a "fly," which was used as a shield to prevent leaking as well as an additional cave from the cold. The heating was done with a "Queen" heater burning wood, which is said to have been greatly used for such work of late years. Each man of the party was provided with four pairs of blankets and a rubber sheet. The bed itself was usually made out of fresh-cut fir branches, laid "shingle" fashion to a depth of about 1 foot. A good day's work was found to be 1 to 1¼ miles. The party had two meals a day in camp—breakfast and supper; the midday meal was brought to them on the line, and consisted of pork, beans, bread, and tea. The toboggans used for transport were 7 feet long by 18 inches wide. These were drawn by a team of three to four dogs, the weight behind the team being 350 pounds to 400 pounds. On a good trail the dogs could cover 30 to 40 miles per day. These dogs were fed but once daily, their rations consisting of 1¼ pounds of corn-meal mixed with ¼ pound of tallow or lard.

The prospect of active work in connection with the ship canal across the Isthmus of Panama has directed attention to the climate of the district, in which engineering work of exceptional difficulty will have to be undertaken. The results, according to Nature, were generally reassuring, and with ordinary care a repetition of the horrors that accompanied the construction of the Panama railway need not be feared. The most noticeable feature in the temperature factor is its constancy throughout the year, the monthly range, in the mean, being confined between 78.4 deg. and 80.1 deg. The daily range on the coast is from 68 deg. to 87 deg., and in the interior from 64 deg. to 94 deg. It is easy to see the effect of the oceans in thus limiting the range of temperature, but necessarily there is an increase in the humidity, which is always high, throughout the year. There is a great difference in the rainfall on the Pacific and on the Atlantic coasts; about 140 inches may be anticipated on the former, while only half that amount will fall on the Atlantic side. From January to April the fall is very slight throughout the Isthmus, and therefore several successive months of dry weather can be counted upon, which cannot but be of great advantage in the engineering operations. Winds are always light, and give no trouble. Greater velocities than twenty miles an hour are rarely met with. The general health statistics are not unfavorable. Recent inquiries show that the mortality due to diseases of the climate has steadily diminished since 1881, while the percentage of deaths arising from European diseases has not increased. Of the total death rate, 91 per cent is due to chronic organic diseases common to all countries, and only 9 per cent is chargeable to local effects. This material improvement is due, in some measure, to the fact that the excavations have reached a level below the poisonous emanations of decaying organic matter, while, on the other hand, greater sanitary precautions have reduced the effects of the most deadly of the infectious diseases, yellow fever. Colon has been practically free from this scourge for some time, but improvements in Panama are loudly demanded.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Roumania's Commercial Methods and Markets.—A report of the Austro-Hungarian consul-general for Roumania as published in the Handels Museum is full of interesting items and suggestions. It says:

"Roumanians often change the places in which they purchase their imports. The merchants buy of many, because they believe it to be best to do so. It often happens that a foreign firm that has had good results will run down in one season to one-third of what it sold the year before. This is due partly to sharp competition and to the agents. An article that has had a great run may be so modified in make-up, quality, etc., as to secure considerable reduction in the selling price. Now, if the Roumanian merchant fails to post the manufacturer from whom he gets his supplies, or the factory fails to find out the cheapening changes made by others, it loses the place it once held and finds it exceedingly hard to regain it. The Germans are always appearing with novelties and modifications. They cause the competition.

"In 1902 Austria-Hungary sold Roumania quite a large number of goods that hitherto came almost exclusively from Germany. Austria is devoting more attention to Roumania's markets. Her success therein is due very largely to the fact that her agents sent thither have been oftener at the places of business of the Roumanian merchants and manufacturers. The great difficulty of finding foreign markets and the efforts to obtain them have taught that to get and hold them parties have to put in a personal appearance, and to do it frequently. This is the only way to secure the sales and to get better prices. Agencies play a very important part in Roumania's trade relations. The representatives, however, are often lacking in knowledge of the branch or branches they represent. This is a great drawback. They accept anything that is offered. Agents will be found selling Swiss cheese, wire, and woolens. Very few Roumanian agents have their business arranged in departments, and few have trained clerks.

"More difficult than securing business is the transaction thereof. One can not be warned too often to go slowly if one wants to go safely and securely. The seller should see to it that he gets an accurate statement of the weight, finishing, color, packing, or putting up of the article or articles to be sold. He should receive this information from his agent. It should be in writing and when this is not possible he should demand and secure samples. Even then, before the goods are shipped, it would be wise to send on samples and ship only after acceptance on this basis by the purchaser. Doing this is of inestimable value in selling textiles. It lightens the labor of all concerned and protects the seller from unjust claims. England ships no goods until she has sent her reference samples and has had them accepted. Thus, for this reason, England seldom or never has a bill of goods refused or sent back. If one gets information to the effect that a man or firm ordering is not reliable, the best thing to do is to refuse to fill the order, otherwise the party ordering will surely take the first chance, on the flimsiest pretext, to put in claims for discounts and for long credit.

"The quoting of credits in Roumania is often very optimistic. Firms with very small active capital often get credits that bear no real relation to their actual financial condition. The result is that they use the easily acquired credits to expand their business far beyond a profit-making margin. It is not wise, therefore, for foreign firms to begin to have direct business relations with the small Roumanian houses. This is particularly true in regard to textiles. Even if better prices are obtained by direct trade, all kinds of claims are made, and it not infrequently happens that shipments have to be sold far below the invoice prices because of inability to otherwise dispose of them, or they must be sent to some other place, thus entailing extra expense."

British Trade in China.—The following observations, published in the British Board of Trade Journal for July 16, on the import and export trade of Nankin are extracted from the acting British consul's recent report to the Foreign Office:

"There can be no doubt that the taste for articles of foreign manufacture is growing among the people. In a native report on the trade of the city I read, for instance, that during the last few years all the native cloth shops in Nankin have been obliged either to close their doors or include foreign piece goods in their stock in trade. . . . A notable feature about the foreign imports into Nankin is the large and increasing share taken by Japan. In the sundries business she is making enormous strides at the expense, as a rule, of Germany, but also of the United Kingdom and the United States. . . . The success of the Japanese is due to the very careful way in which, with the assistance of their government, they study the Chinese market and supply exactly the kind of foreign luxuries that the people want at a price which brings them within the reach of all. The quality of their goods is very poor, but they look good, and their cost is far below that of similar articles purchased in Europe. . . . The demand for foreign soap has been growing so rapidly among the Chinese that no less than three native companies have been formed within the last year or so to import the necessary machinery and manufacture the article locally. Only one of the companies seems to have come to anything, but the soap it manufactures has already a large and increasing sale in the city, and, as the returns show, a small quantity has even been exported. . . . It is true that the whole trade of the port is at present of little consequence, but business connections might now be formed which later on will be invaluable. . . . "

The acting consul, in writing of the British trade at Wuchow, adds:

"There are now ten British firms in Wuchow, all represented by Chinese agents; these firms include two of the largest British houses in China, and it is, I think, matter for regret that they do not see their way to send a young Englishman here to push their interests. I am quite aware that the experiment has been tried and proved a failure, but conditions have changed during the last two years. Wuchow has grown in importance; competition, especially in the shipping business, has become keener, and if our people, at whose instance this river was opened to trade and who enjoy exceptional opportunities for prosecuting successfully their undertakings in this part of China, wish to maintain their present position in this West River trade, it is high time some serious efforts were made to this end."

Development of the World's Steel Industry.—The Deutsche Industrie Zeitung says that of all the countries producing steel in 1902 the United States led, with an output of 15,000,000 tons. These figures grow in importance when it is remembered that the world's production in 1894 was only 12,851,000 tons. Germany's production in 1902 was 7,780,000 tons, one-half that of the United States; while England's was only 5,000,000 tons, or one-third the production of the United States. The world's total steel output for 1902 was estimated at 35,000,000 tons. This would indicate a growth of 700 per cent in twenty-two years, or an increase from a little more than 4,000,000 tons in 1880 to 35,000,000 tons in 1902. The great increase is due to the introduction and improvement of the processes, notably the flame furnace. Pennsylvania leads all parts of the world in the use of this furnace, followed by Illinois, New England, Ohio, etc.

The steel produced by the Bessemer process during the last fifteen years was used mostly for rails. In England more than half of the steel produced by the Bessemer process went into rails. In Germany and the United States the proportion is not so large. While the United States produced 9,306,471 tons of steel ingots in 1902, it turned out only 2,876,293 tons of steel rails, or about 30 per cent of the steel-ingot production. In Germany the amount of Bessemer steel put into rails is proportionately smaller. Because of the resisting power of the steel, the wear and tear on the rails is far less; but the manifold uses to which the steel can be put has taken away somewhat from the importance of steel-rail manufacture. The last twenty years has resulted in an age of steel. Three times as much steel is now produced as in 1894. The universal opinion seems to be that the production of steel is to go on increasing. If, during the next twenty years, the same rate of increase is maintained as marked the past, 1923 will see an advance of from 20,000,000 to 25,000,000 tons in the world's total production. In this enormous increase the United States, according to experts, is to play the important part. At the very least, this opinion seems reasonable. The United States now uses in a year 30,000,000 tons of the very best iron ore. In twenty years this would mean a total of 600,000,000 tons—possibly the exhaustion of the sources of supply.

Jute Crop of India of 1903.—As about 60 per cent of the jute manufacturers and nearly 15 per cent of the raw jute exported from India go to the United States, the following statistics, compiled from the "First forecast of the jute crop in Bengal, where most of the jute is raised for the season 1903," by the officiating director of the department of land records and agriculture, Bengal, are submitted. Returns have been received from 26 districts in Bengal, the area under jute in the remaining 21 districts being insignificant. About two-thirds of the crop is grown in eastern Bengal, while one-third comes from the northern districts. The present forecast contains figures for the area sown and the probable outturn of the crop, as estimated up to the middle of June.

The weekly weather and crop reports from the important jute-growing districts show marked deficiency of rain in April and to some extent in May.

The collectors report deficiency of rain at the time of sowing from all the jute-growing districts except Murshidabad and Balasore, where areas under jute are comparatively unimportant.

Not less than 2,300,000 acres may be taken as the normal area under jute and 7,500,000 bales as the normal outturn.

The reports last year show that 2,200,000 acres were sown and the figures of exports and consumption show the crop to have been not less than 5,800,000 bales.

The present season collectors report the area under jute as 2,019,000 acres. It is undoubtedly the fact that a smaller area has been sown this year than last, owing to the want of rain at the time of sowing; but, having regard to the marked tendency to underestimate, it is safe to assume that the area under jute this year is not less than 2,100,000 acres. Notwithstanding the smaller area, the estimate for outturn given by district officers are, on the whole, more favorable than last year.

As the area sown this year is less than 10 per cent below the normal crop, it is believed the outturn will be 5,400,000 bales.—R. F. Patterson, Consul-General at Calcutta.

Failure of the Cocoon Crop of Piedmont.—The province of Piedmont in northwestern Italy is noted as the most productive cocoon section of the kingdom. Last year my attention was attracted by the enormous quantities of cocoons that were brought to this market, the peasants, with their huge, overflowing baskets and sacks, occupying several squares of the magnificent Victor Emmanuel Avenue. This year, to my surprise, the assemblage of peasants, their cocoon crops, and purchasing merchants present a sorry gathering.

I have visited the market several times, mingled with and conversed with producers and buyers, and learned these facts: Late frosts and prolonged cold weather kept the mulberry trees almost leafless, thus leaving the peasants without sufficient food for the growing worms. The mulberry leaves are the natural food of the silkworm, and the crop of foliage being so notably a failure at a critical time, other means to keep the worms alive had to be resorted to, but with disastrous results. The consequence is that the cocoon crop for the year is about 4,500,000 pounds or one-third the amount of last year's crop. This is the estimate given me by several leading cocoon purchasers of Turin.

As is always the case, when an important article of consumption is scarce, the price goes up; hence the price of cocoons is about one-fourth more than it was at this time last year—two points of importance for Americans interested in the silk industry.—Pietro Cuneo, Consul at Turin.

World's Demand for Tool-Making Machines.—The Deutsche Industrie Zeitung, in its issue of July 17, 1903, calls attention to a congress or convention of Germany's tool-machinery makers. Reports of those present went to show an increase of business in the empire; but the orders were not large enough nor the prices satisfactory. The orders from the government were not nearly as large as desired. Complaint was made against the custom of the large iron mills of contracting for machinery only on condition that part payment be made in the iron or steel products of the mills. Another evil complained of is the custom of the iron or steel mills of making their own conditions when contracting, instead of following, as formerly, well-established customs. In the matter of contracts in which it is provided that the tool makers take steel or iron from the mill, great abuses have crept in. The contract provides sometimes that fully 50 per cent of the bill be paid in material. Inasmuch as the greater part of a tool-making machine's value lies in the labor expended on it and the most of the material is cast iron, the demand of the mill to be allowed to pay for it in its products seems unfair and unjust. It is thought that little can be done in individual or isolated cases, but that a combination of the machine builders might effect a reform. Reports made to the convention regarding foreign trade show a decline. In France everything was quiet, Italy offers little encouragement, Spain promises great things by and by, particularly for the marine. The United States, it was said, must be given up as hopeless because of its own development of machine making.

Efforts of French Exporters to Get Foreign Trade.—Das Handels-Museum of July 2, 1903 (organ of the Austrian government), says:

"Louis Olivier, editor of the Revue Générale, is organizing a party of French exporters to visit the Levant for the purpose of studying its trading possibilities. He has secured the support of a great many geographical societies, chambers of commerce, and industrial unions in France, Algiers, and Tunis. Parties already doing business with the Levant are expected, of course, to be very much interested in the movement. Even these, however, by means of personal contact with the merchants of the Levant, will be able to form new and profitable trade connections. Teachers and scholars of the higher grade commercial schools are expected to join the party, which is to sail from Marseilles about the middle of October on a steamer chartered for the trip and expects to visit every important city in the Levant and make long stays—several days at least in Constantinople, Smyrna, Salonika, Athens, etc. The members of the French Chamber of Commerce at Constantinople are to aid in every way to secure such information as will help to make the expedition successful. It is hoped that this is only the beginning of many like expeditions, and that France is to lose at last that indifference to foreign travel which handicaps her in competition with other industrial states."

American Branch Industries in Ontario.—The establishment of American branch industries in Canada is steadily on the increase. Among the latest of such concerns announcing their intention to establish plants in Ontario may be mentioned the United States Steel Corporation, which, so it is reliably stated, will construct extensive works at Port Colborne, Ontario, at an early date. The company, I am informed, has already secured concessions from the Dominion Government for dredging a basin at the entrance of the Welland Canal, and has arranged for 6,000 electric horse power from Niagara Falls, Ontario. Another proposed new industry for Ontario is the Canadian Westinghouse Company, which has been incorporated with a capital of $2,500,000, to manufacture electrical machinery, safety devices, etc., at Hamilton, Ontario. The provisional directors include P. J. Myler, Hamilton; W. Y. Soper, Ottawa; and George Westinghouse and G. C. Smith, of Pittsburg, Pa.—E. N. Gunsaulus, Consul, Toronto, July 22, 1903.

Furs and Fur-Bearing Animals in Siberia.—The fur trade in this province is in a critical condition. Prices have fallen very much and first-class furs are hard to get. Buyers complain that through the action of some English traders a few years ago in paying extravagant prices to the natives for furs—furs ultimately sold by the buyers at a loss—the regular prices were greatly inflated. Hunters complain that fur-bearing animals are constantly growing scarcer in Siberia.—R. T. Greener, Commercial Agent, Vladivostock, May 10, 1903.

Exports of Antiques from Italy Forbidden.—The Official Gazette of Italy says that by a law of June 27, 1903, the exportation of antiquities found in excavations and that have an archeological and artistic value—also articles of antiquity of artistic value in the possession of private parties, regarded by the government as having great value for historical and artistic purposes—is forbidden. The law is to be in force for two years. The government reserves to itself the right to buy the articles during the two years. The law applies to antiquities and art works for which applications for permission to export have been made since June 26, 1903.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1743. September 8.—Agricultural Implements and Vehicles in Foreign Countries.

No. 1744. September 9.—Gold and Manganese Mining in British Columbia—Failure of the French Sardine Catch—Increased French Duties on Cattle and Meats—Consular Notes: Insurance Business in Germany—American Opportunity in Austria—Trucks for Electric and Steam Railway Cars—Trade Opportunities Abroad: Mexico's Trade.

No. 1745. September 10.—Agricultural Implements and Vehicles in Foreign Countries.

No. 1746. September 11.—*Brewing Industry of Kulmbach—Australia, the Orient and San Francisco—Schools for Agriculture in Quebec—Importation of Machinery into South Africa—New German Customs Tariff—Consular Notes: Steam-propelled Passenger Cars—Rubber Tires for Vehicles—Drawback to American Trade in Colombia—*Porcelain Pipes for Waterworks—Trade Opportunities Abroad: Mexican Imports and Exports in 1902 and 1903.

No. 1747. September 12.—Agricultural Implements and Vehicles in Foreign Countries

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

TRADE NOTES AND RECIPES.

Varnish for Brass.—

Iron sesquioxide	28 grammes
Arsenious acid	28 grammes
Hydrochloric acid	340 c. cm.

Dissolve the salts in the acid. Brush the metal with this solution until the desired color is obtained and burn the metal dry to produce brilliancy.—Science Illustrée.

Another Solder for Aluminium.—The following composition for soldering aluminium is recommended by an American firm, who state that it gives a strong and durable joint between two pieces of aluminium or alloys of that metal, viz.: Zinc, by weight, 90 per cent; aluminium, 5 per cent; antimony, 5 per cent. The solder is still stronger if 8 per cent of antimony and 87 per cent of zinc is used. The aluminium is first melted in a crucible and the zinc added gradually. When the latter is melted the antimony is put in and the alloy mixed intimately with salammoniac. When the surface of the molten metal is clear and white, the slag is removed and the solder cast in bars. The surfaces to be soldered are first cleaned with acid and then coated with solder, care being taken that the latter penetrates the surface of the metal under the action of the fire without its being burnt. The pieces are then brought into contact and heated; the excess of solder is removed while still liquid and the whole is allowed to cool.—Mechanical Engineer.

Action of Fatty Bodies on Metals.—Mineral oils do not attack zinc and copper; they attack brass very little and lead more strongly.

Olive oil attacks tin the least and copper the most.

Rapeseed oil attacks neither tin nor brass; it corrodes iron the least and copper the most.

Tallow oil attacks tin least and copper most.

Cotton oil has the least action on lead, the strongest on tin.

Spermaceti oil acts least on brass and most on zinc.

Whale oil does not attack tin, acts little on brass and most on lead.

Seal oil attacks brass the least and copper most.

Upon inverting the question the following results are found:

Iron is attacked most strongly by tallow oil and the least by seal oil.

Brass is attacked most by olive oil, least by seal oil; rapeseed oil has no action on it.

Tin is not acted upon by rapeseed oil, very slightly by olive oil and most by lard oil and whale oil.

Zinc is not attacked by the hydrocarbons and lard oil, and most by whale oil.

Copper is not attacked by mineral oils; it is least corroded by whale oil and most by tallow oil.—La Science Pratique.

Composition of Some Washing Agents.—Hinterskirch and Kraft give the following analyses of some washing agents:

Grosser's Washing Brick.

	Per Cent
Water	54.00
Soda	38.21
Borax	6.61
Soluble glass	1.70

Henkel's Bleaching Soda.

Water	36.16
Soda	40.22
Soluble glass	23.14
Residue (soap?)	0.48

Luhn's Washing Extract.

Water	34.50
Soda	25.33
Soap	39.40
Residue (cooking salt, silicic acid)	0.77

Minlos' Washing Powder.

Water	38.00
Soda	53.50
Soap	2.65
Soluble glass	4.55
Residue (impurities)	1.30

—Zeitschrift für Untersuchung der Nahrungsmittel.

Polish for Tan and Russet Shoes.—The liquid application consists usually of a solution of yellow wax and soap in oil of turpentine, and it should be a matter of no difficulty whatever for the pharmacist to compound a mixture of this character at least equal to the preparations on the market. As a type of the mixture occasionally recommended we may quote the following:

Yellow wax	iv ounces
Pearl ash	iv drachms
Yellow soap	ij drachms
Spirit of turpentine	viij ounces
Phosphine (anilin)	iv grains
Alcohol	iv drachms
Water, a sufficient quantity.	

Scrape the wax fine, and add it, together with the ash and soap, to xij ounces of water. Boil all together until a smooth, creamy mass is obtained; remove the heat and add the turpentine, and the anilin (previously dissolved in the alcohol). Mix thoroughly, and add sufficient water to bring the finished product up to 1½ pints.

A simpler form of the liquid mixture consists of equal parts of yellow wax and palm oil dissolved with the aid of heat in three parts of oil of turpentine.

Another formula which has found favor is the following:

Soft, or green, soap	ij ounces
Linseed oil, raw	iij ounces
Annatto solution (in oil)	viij ounces
Yellow wax	iij ounces
Gum turpentine	viij ounces
Water	viij ounces

Dissolve the soap in the water and add the solution of annatto; melt the wax in the oil of turpentine, and gradually stir in the soap solution, stirring until cold.

The paste to accompany the foregoing mixtures is composed of yellow wax and resin thinned with petrolatum, say 4 parts of wax, 1 part of resin and 12 parts of petrolatum, mixed *secundum arte*.—Am. Druggist.

JUST READY.

DIES, THEIR CONSTRUCTION AND USE,

For the Modern Working of Sheet Metals.

By JOSEPH V. WOODWORTH.

Octavo. Cloth. Very Fully Illustrated. Price $3.00 Postpaid.

This book is a complete treatise on the subject and the most comprehensive and exhaustive one in existence. A book written by a practical man for practical men, and one that no diemaker, machinist, toolmaker or metal-working mechanic can afford to be without.

Dies, press fixtures and devices from the simplest to the most intricate in modern use, are shown, and their construction and use described in a clear, practical manner, so that all grades of metal-working mechanics will be able to understand thoroughly how to design, construct and use them, for the production of the endless variety of sheet-metal articles now in daily use.

Many of the dies described in this book were designed and constructed by the author personally, others under his personal supervision, while others were constructed and used in the press rooms of some of the largest sheet-metal goods establishments and machine shops in the United States. A number of the dies, press fixtures and devices, which form a part of this book, have been selected from over 150 published articles, which were contributed by the author to the columns of the "American Machinist," "Machinery" and the "Age of Steel," under his own name.

No obsolete die, press fixture or device has found a place in this book; every engraving between its covers represents the highest that has been attained in the development of each type described. The descriptions of their construction and use will enable the practical man to adapt them for facilitating, duplicating and expediting the production of sheet-metal articles at the minimum of cost and labor.

Every manager, superintendent, designer, draftsman, foreman, diemaker, machinist, toolmaker or apprentice should have this book.

JUST PUBLISHED.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL.

By JOSEPH V. WOODWORTH,

Author of "Dies, Their Construction and Use."

Octavo. 220 pages. 100 Illustrations. Bound in Cloth. Price $2.50.

A new work from cover to cover, treating in a clear, concise manner all modern processes for the **Heating, Annealing, Forging, Welding, Hardening and Tempering** of steel, making it a book of great practical value to metal-working mechanics in general, with special directions for the successful hardening and tempering of all steel tools used in the arts, including milling cutters, taps, thread dies, reamers, both solid and shell, hollow mills, punches and dies, and all kinds of sheet metal working tools, shear blades, saws, fine cutlery, and metal cutting tools of all description, as well as for all implements of steel, both large and small. In this work the simplest and most satisfactory hardening and tempering processes are given.

The uses to which the leading brands of steel may be adapted are concisely presented and their treatment for working under different conditions explained, also the special methods for the hardening and tempering of special brands. In connection with the above, numbers of "kinks," "ways," and "practical points" are embodied, making the volume a text book on the treatment of steel as modern demands necessitate.

A chapter devoted to the different processes of **Case-hardening is also included**, and special reference made to **the adoption of Machinery Steel for Tools** of various kinds. The illustrations show the mechanic the most up-to-date devices, machines and furnaces which contribute to the attainment of satisfactory results in this highly important branch of modern tool-making. Send for descriptive circular.

MUNN & CO., Publishers, 361 Broadway, New York.

THE

Scientific American Supplement

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from commencement, January 1, 1876, can be had. Price 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

I. ASTRONOMY.—The Zone of the Little Planets or Asteroids.....

II. AUTOMOBILES.—Automobile Cultivators.—2 illustrations.....

III. COMMERCE.—German Engineering Impressions of the United States.....

IV. ELECTRICITY.—Contemporary Electrical Science.....
Electricity and Matter.....
The Electrical Conductivity of Fire Streams.—4 illustrations.....

V. FINE ARTS.—Greek Painting in the Alexandrian Period.....

VI. FISHERIES.—The North Sea Fisheries.....

VII. MAGIC.—"La Strobelka Persane."—3 illustrations.....

VIII. MECHANICAL ENGINEERING.—Mine Hoist Combined with Gasoline Engine.—1 illustration.....

IX. MECHANICS.—The Mechanical Handling and Conveying of Coal and Coke.—III.—By EMILE GUARINI.—3 illustrations.....

X. METALLURGY.—Aluminothermy.—3 illustrations.....
Treatment of Pyrites Containing Combined Gold.....

XI. MINERALOGY.—How to Tell a Diamond and Appraise Its Value.....

XII. MISCELLANEOUS.—Electrical Notes.....
Engineering Notes.....
Trade Notes and Recipes.....
Trade Suggestions from United States Consuls.....

XIII. NATURAL HISTORY.—Eyes That See in the Dark.....
Herds of Wild Horses Still in Existence.....

XIV. PYROTECHNY.—Pyrotechny for Pharmacists.....

XV. STEAM ENGINEERING.—Steam Turbines.—By Prof. R. H. THURSTON.....

XVI. TECHNOLOGY.—Manufacture of Spirit Varnishes.—By Ch. COFFIGNIER.....

Scientific American

BUILDING MONTHLY

ESTABLISHED IN 1885

Appeals to the Architect and Builder	Because it illustrates the latest works of other architects and builders. Because it publishes timely articles and notes on ventilating, plumbing, legal matters, etc. Because it has interesting talks with prominent architects.
Appeals to Those About to Build	Because it publishes views of country houses of varying architectural styles and costs in all sections of the country, only illustrating those actually built. Full floor plans and descriptions are given.
Appeals to Women	Because it is filled with suggestions relative to color schemes, draperies, wall paper, furniture, painting, sculpture, etc. Many examples are illustrated. Interiors are published in every number.
Appeals to Garden Lovers	Because it contains examples of artistic gardens, from the simplest to the most elaborate formal and Italian gardens, pergolas, summer houses, fountains, etc. Even the stable is not neglected.
An American Journal for the American	Because only American country houses and buildings are published. No foreign designs are accepted.

PRICE, $2.50 PER YEAR. SAMPLE COPY, 25 CENTS.

MUNN & CO., Publishers, 361 Broadway, New York.

ARCHITECTS SHOULD SUBSCRIBE MANUFACTURERS SHOULD ADVERTISE

PATENTS

In connection with the publication of the above-mentioned journal, Messrs. MUNN & COMPANY have for fifty years acted as solicitors in preparing and prosecuting applications for patents, trade-marks, etc., before the Patent Office. HAND BOOK on Patents sent free on application. Patents procured through us are noticed without charge in the *Scientific American*.

MUNN & CO., Solicitors, 361 Broadway, New York City

Branch Office, WASHINGTON, D. C.